UNIVERSITY OF ARIZONA LIBRARY
3 9001 49980 6464

A Report of The Total Quality Leadership Steering Committee and Working Councils

November 1992

A Report of The Total Quality Leadership Steering Committee and Working Councils

November 1992

Copyright © 1992
The Procter & Gamble Company

contents reprinted with the permission
of the contributors, 1992

Foreword

In 1991, two hundred university and industry leaders assembled for two and a half days to identify ways to accelerate the teaching, research, and practice of total quality in the United States.

At the conclusion of the 1991 Total Quality Forum: Forging Strategic Links with Higher Education, a Leadership Steering Committee was formed to ensure that the recommendations of the conference participants were implemented. The Committee chartered six working councils to address the crucial issues in moving forward.

After months of careful study, the committee and its councils issued this report which addresses the following:

- Provides an understanding of what total quality is and how it is currently practiced.
- Identifies the methods and principles of total quality that employers would like to see integrated into engineering, business, and other curricula so new employees understand and practice them.
- Recommends strategies and processes for integrating total quality into the curricula, developing teaching materials, and identifies some examples of outstanding practices and processes of study related to total quality.
- Proposes actions to accelerate the mastery of total quality principles by faculty.
- Examines current research on total quality and identifies key research directions that would develop the thinking and accelerate the practice of total quality.
- Identifies the elements that are key to implementing total quality in a university setting.

The conclusions of the Leadership Steering Committee and working councils were presented in November at the 1992 Total Quality Forum and it is with great pleasure that the Leadership Steering Committee publishes this report of the findings and recommendations of the working councils.

American Express, General Motors, IBM, Milliken, 3M, Motorola, Procter & Gamble, and Xerox provided the financial support for the working councils, the forum, and the development of this report. A special thanks to these companies and to all of the members of the Leadership Steering Committee and the working councils for their contribution to this important effort.

We look forward to a more globally competitive United States as higher education and business work in partnership to accelerate the development and deployment of total quality in our country.

Edwin L. Artzt
Chairman of the Board and Chief Executive
The Procter & Gamble Company

Digitized by the Internet Archive
in 2022 with funding from
Kahle/Austin Foundation

https://archive.org/details/reportoftotalqua0000vari

Contents

Report of The Leadership Steering Committee 1-1

Core Body of Knowledge Working Council: Perspectives on Total Quality 2-1

Employers' Needs Working Council 3-1

Total Quality Curricula, Materials and Programs Working Council 4-1

Total Quality Faculty Development Working Council 5-1

Total Quality Research Working Council 6-1

University Practice of Total Quality Working Council 7-1

Report of The Leadership Steering Committee

by John P. Evans
Advisor to the Leadership Steering Committee and
Professor of Business Administration
Kenan-Flagler Business School
The University of North Carolina at Chapel Hill

Leadership Steering Committee Membership

John F. Akers
Chairman of the Board, IBM
Paul A. Allaire
Chairman and Chief Executive Officer, Xerox Corporation
Edwin L. Artzt
Chairman of the Board and Chief Executive, The Procter & Gamble Company
John V. Byrne
President, Oregon State University
Livio D. DeSimone
Chairman of the Board and Chief Executive Officer, 3M
Meyer Feldberg
Dean, Graduate School of Business, Columbia University
Christopher B. Galvin
Senior Executive Vice President and Assistant Chief Operating Officer, Motorola, Inc.
Roger Milliken
Chairman and Chief Executive Officer, Milliken & Company
C. Warren Neel
Dean, College of Business Administration, University of Tennessee at Knoxville
John E. Pepper
President, The Procter & Gamble Company
Frank H.T. Rhodes
President, Cornell University
James D. Robinson III
Chairman and Chief Executive Officer, American Express Company
William R. Showalter
Dean, School of Engineering, University of Illinois
Donna E. Shalala
Chancellor, University of Wisconsin at Madison
Robert C. Stempel
Chairman, General Motors Corporation
Charles M. Vest
President, Massachusetts Institute of Technology
John A. White
Dean of Engineering, Georgia Institute of Technology
B. Joseph White
Dean, School of Business Administration, University of Michigan

Contents

I. Origin of the Total Quality Forums

II. Urgency of the Topic

III. Setting the stage for Total Quality Forum 1992

IV. Core Body of Knowledge, Status of Total Quality in Higher Education, and Employers' Needs

V. Recommendations for Universities

VI. Recommendations for Businesses

VII. Actions of the Leadership Steering Committee

VIII. Conclusion

Report of The Leadership Steering Committee

I. Origin of the Total Quality Forums

On August 1, 1989, David Kearns, then Chief Executive Officer of Xerox Corporation, convened several of his senior colleagues from Xerox, senior executives from another six businesses, faculty and deans representing 20 schools of business, and representatives of several additional organizations associated with business education and quality for the first Total Quality Forum. Mr. Kearns opened the first session by saying that his objective was to promote interchanges between the business and academic communities on an issue of common interest: teaching Total Quality.

Mr. Kearns explained his reasons for organizing the first Quality Forum by saying that he had become convinced that trade barriers don't work in the long run and that he had also become convinced that the important skills and insights (for business success in today's global markets) could be learned. He believed that an understanding of Total Quality was one of those essential skills for today's managers and, on behalf of the business community, he was looking for help in the form of a partnership with the academic community. In a key portion of his remarks he mentioned his belief that the managers and workers in Japanese companies subject themselves to more pressure to perform to the expectations of their customers than had been typical of American companies.

In expressing eagerness to work with business schools, Mr. Kearns indicated a number of expectations of those schools. The prominent items on his list appear below.

- Graduate people who understand quality issues.
- Get TQ topics and courses into the curriculum.
- Get marketing people to be customer-oriented.

- Prepare a foundation for flexible, broad-based managers.
- Work with the business community to establish quality as a major tool.

In his opening comment and again in his closing comment he said, "I hope it works." As the three-day conference proceeded it became clear to those attending that Mr. Kearns' notion of "working" meant not only how well-received the Forum would prove to be, but also the degree to which progress would occur on the expectations that he identified.

This report describes many events that can be traced to that first Total Quality Forum. That first Forum served as a very powerful stimulus. Much progress can be reported. Much more is known about Total Quality. Much activity is underway. But much remains to be done. As we approach Total Quality Forum 1992 we might amend Mr. Kearns' comment to say, "We think it's working, but more remains to be done." This report is a summary of status, directions, recommendations, and actions taken to advance toward these ends.

II. Urgency of the Topic

Mr. Kearns expressed a set of needs of the business community that he hoped the academic community could help to address. These needs were partly a reflection of experiences of Xerox and other American corporations in the preceding ten years. A concise summary of these experiences was provided by Dertouzos, Lester, Solow, et al [2] as follows.

> *Certain American industries that once dominated world commerce ... have lost much of their market share both at home and abroad; in a few industries ... the American presence in the market has all but disappeared. (pp. 1-2)*

While Mr. Kearns was not arguing that Total Quality was the unique solution to these issues, he did state emphatically that implementation of the concepts and practices associated with Total Quality had played a central role in the successful efforts at Xerox Corporation to regain market share that had been lost.

Part of the point is that the intensification of international competition has made high quality a necessary condition for market success. However, the term "quality" has historically suggested the narrow definition of "product quality" in this country. Robert Reich [4] provides a larger context for these issues in observations about transitions in global markets.

> *(T)he firms that are surviving and succeeding are shifting from high volume to high value. (p. 82)*
>
> *America's core corporations are gradually, often painfully, turning toward serving the unique needs of particular customers. (p. 82)*
>
> *In the high-value enterprise, profits derive not from scale and volume but from continuous discovery of new linkages between solutions and needs. (p. 85)*
>
> *The real economic challenge facing the United States in the years ahead — the same as that facing every other nation — is to increase the potential value of what its citizens can add to the global economy, by enhancing their skills and capacities and by improving their means of linking those skills and capacities to the world market. (p.8)*

As the results reported later in this paper will indicate, the issues raised by Reich, although not placed under the heading of Total Quality, have a large intersection with that topic.

Lester Thurow [5] addressed many related issues in his assessment of the anticipated international economic competition.

> *In the future sustainable competitive advantage will depend more on new process technologies and less on new product technologies. (p.16)*
>
> *In the century ahead natural resources, capital, and new- product technology are going to rapidly move around the world. People will move — but more slowly than anything else. Skilled people become the only sustainable competitive advantage. (pp. 51-2)*

Thurow then makes an interesting point concerning the demand for better processes as differentiated from the challenge of creating innovative products. He argues that the latter depends on the abilities of the smartest 25 percent of the labor force. In contrast, he concludes that creating better processes depends critically on the education level and skills of the "bottom 50 percent of the population." To the extent that the notion of process technology includes not only operation but also improvement of processes, this statement invokes the concept of continuous improvement that we associate with Total Quality. In referring to process technologies Thurow may have meant primarily the

processes by which products are created. His argument is equally applicable to a broader notion of process technology — all key processes that must be executed effectively if an organization is consistently to meet the expectations of its customers.

Thomas J. Murrin [3] — former President of the Energy and Advanced Technology Group of Westinghouse Electric Corporation, former Deputy Secretary of Commerce, and currently Dean of the A. J. Palumbo School of Business Administration at Duquesne University — succinctly connected these challenges of surviving in global economic competition to the role of Total Quality.

> *The effort to incorporate Total Quality in the academic community is one of the most important things happening in our country, because it deals with the central issue of supplying human resources to the key organizations in our society.*

The remainder of this paper reports on a strengthening partnership between the business and academic communities to address these challenges.

III. Setting the stage for Total Quality Forum 1992

That first Total Quality Forum in 1989 has had two important successors. Total Quality Forum 1990 was larger and included representatives from both business and engineering schools. The 1991 Forum had still larger attendance, included additional representation from engineering schools, and included representation of programs in health administration. The 1991 Forum also included expanded sponsorship. The Procter & Gamble Company served as host with overall sponsorship shared among American Express Company, Ford Motor Company, IBM Corporation, Motorola, Inc., and Xerox Corporation.

Each Forum included panels of top executives from companies that had committed to quality improvement efforts, presentations on the underlying concepts of Total Quality, discussion of case studies of quality improvement efforts, and presentations of curriculum development and research activities under way or completed at institutions of higher education. Each Forum also included break-out sessions that were used to discuss topics ranging from barriers to integrating TQ in the curriculum to steps that needed to be taken to achieve progress in teaching, research, and university practice of TQ.

Mr. Edwin L. Artzt [1] — Chief Executive of The Procter & Company which hosted Total Quality Forum 1991 — summarized the objectives that were defined during the discussions.

- Define the core knowledge generic to TQ — the central content meaningful to practitioners, scholars, and teachers that will serve as a foundation for the integration of TQ in curricula.
- Propose curricula and materials for teaching TQ in business and engineering schools at both undergraduate and graduate levels.
- Develop strategies to facilitate educators' understanding of and commitment to teach and practice TQ.
- Create a national research agenda for TQ.

Following shortly after the conclusion of Total Quality Forum 1991, Mr. Artzt organized a Leadership Steering Committee to insure that these objectives are achieved. The membership of the Committee appears in an appendix to this paper. The Committee consists of leaders from both the business and academic communities. The Committee, in turn, created a system of Working Councils to carry out this work and to report at Total Quality Forum 1992 in November. The Working Councils and their assignments are listed below.

Core Body of Knowledge Working Council

What is Total Quality? Inventory and synthesize the core principles and practices of TQ. Produce a summary of what TQ is and how it is currently practiced.

Employers' Needs Working Council

Which TQ principles and methodologies should be taught in business and engineering schools? Create a summary of what employers would like business and engineering school graduates to know about TQ. Recommend which principles and recommendations should be integrated into curricula.

Curricula, Materials, and Programs Working Council

How should curricula be designed to include TQ? What materials need to be developed to support this? Develop a summary of where and how TQ is being taught. Describe programs that focus on TQ and report on the status of teaching materials to support TQ instruction. Recommend how TQ should be taught and identify what materials need to be developed.

Faculty Development Working Council

How should faculties' understanding of and commitment to teach TQ be developed? Analyze existing processes for building the understanding and skills of faculty to teach TQ focusing initially on business and engineering schools. Recommend approaches for developing faculty understanding and increasing faculty commitment to teaching TQ.

Total Quality Research Working Council

What don't we understand about TQ that needs to be researched? Gather information on the state and content of TQ research activities and on industry's needs for TQ research. Provide a summary of key TQ research activities and output. Recommend what knowledge needs to be developed and communicated.

University Practice of Total Quality Working Council

How should TQ be practiced in higher educational institutions? Inventory how and where TQ is being practiced in colleges and universities. Recommend how a TQ process should be implemented in an institution of higher education.

Except for the last Council listed above which consisted entirely of members from the academic community, each Council was a partnership with roughly equal membership from the business and academic communities. This cooperation was also reflected in the Co-Chairs of each Council.

Many interdependencies among these Working Councils should be apparent, but the Core Body of Knowledge Council clearly plays a foundation role in support of each of the other Councils. For that reason some of the key results of that Council appear first in the following section of this report. The following section also contains interesting results from a survey conducted by the Faculty Development Council on the status of Total Quality in higher education and results from the Employers' Needs Working Council.

In many instances multiple Councils submitted similar or overlapping conclusions and recommendations. This independent reinforcement of various positions is valuable but for economy of presentation in this report, this work has been reorganized in the following sections. Section IV contains a working definition of Total Quality and related material, information on the status of Total Quality in business and engineering schools in the U.S., and a summary

statement based on the report of the Employers' Needs Working Councils. Section V contains recommendations for universities that cover teaching and curriculum, practice, and research. Section VI contains recommendations for businesses and Section VII contains a summary of actions taken by the Leadership Steering Committee at and following its meeting on October 5, 1992.

Each Working Council report provides a summary of methodology and a statement of conclusions and recommendations related to that Council's assignment. Thus, these reports contain far more information than can be summarized adequately here. The reader interested in the detailed results of a specific Working Council is encouraged to review that report. These Council reports will be discussed at Total Quality Forum 1992 and they will appear in the proceedings of that Forum.

IV. Core Body of Knowledge, Status of Total Quality in Higher Education, and Employers' Needs

A. Core Body of Knowledge and Basic Definition

Building on the general assignment outlined in Section III, the Core Body of Knowledge Council adopted the following charter which recognizes multiple customer sets for its work.

The Core Body of Knowledge Working Council is to define a core of knowledge generic to Total Quality that will be:

- Accurate;
- Meaningful to practitioners, scholars, and teachers;
- A foundation for the integration of Total Quality into the curricula, useful for guiding academic research in Total Quality, and helpful to university administrators who wish to apply Total Quality concepts.

This Council has sought extensive exchanges of ideas within its membership, as well as contributions from a range of individuals with widely varying perspectives on Total Quality. In fact, this Council's report reflects the diversity of those perspectives, indicating that Total Quality is not yet a monolithic, standardized set of concepts, even though a considerable area of agreement has been established. This diversity itself in the Council's report will be a valuable resource for teachers who might want to consider different ways of presenting this material in various teaching environments.

Total Quality: Basic Definition

Total Quality is a people-focused management system that aims at continual increase of customer satisfaction at continually lower real cost. Total Quality is a total system approach (not a separate area or program), and an integral part of high-level strategy; it works horizontally across functions and departments, involves all employees, top to bottom, and extends backwards and forwards to include the supply chain and the customer chain. Total Quality stresses learning and adaptation to continual change as keys to organizational success.

The foundation of Total Quality is philosophical: the scientific method. Total Quality includes systems, methods, and tools. The systems permit change; the philosophy stays the same. Total Quality is anchored in values that stress the dignity of the individual and the power of community action.

This definition clearly places emphasis on increasing customer satisfaction, but without suggesting in any way that the concept of "quality" is limited to quality of product. Two brief illustrations may help to indicate the scope of this definition. First, the definition implicitly admits the concept of cycle time reduction, either as a direct means of increasing customer satisfaction, or as a means of reducing the real cost of a process, or both. Second, the first sentence clearly associates with Total Quality the concept of "continuous improvement."

Also of value in the report of this Council is a brief discussion of aspects of Total Quality about which various people have differing views. This material, as well, will be important for practitioners, scholars, and teachers. Finally, the report contains a valuable list of readings that span the underpinnings of the Council's work and the basic definition presented above.

B. Status of Total Quality in Higher Education

The Faculty Development Working Council anticipated a need for information about the status of Total Quality in business and engineering schools. Such information would serve as one input to an assessment of the need

for faculty development. A survey was distributed to 976 deans of engineering and business schools in the United States and a 53% initial response rate was achieved. This high response rate made it unnecessary to conduct a follow-up to raise the response rate. The 515 responses were from 355 business units and 160 engineering units, which tracks closely with the fact that the ratio of business schools to engineering schools in the U.S. is roughly seven to three. The tables that follow provide insight into attitudes, teaching activity, research, and practice related to Total Quality in these units.

The first question was designed to provide insight into attitudes among deans about Total Quality. The deans were asked the following question.

How important is it to teach principles and methods of Total Quality at your school?

	Deans	Deans' Perceptions of Faculty Views
Extremely Important	57%	12%
Very Important	35%	26%
Somewhat Important	5%	38%
Not Very Important	0%	8%
Not at All Important	1%	11%
No Answer/Don't Know	3%	17%

This table indicates that 92% of the deans responding feel that Total Quality is either a very or extremely important topic. However, only 38% of those deans perceive that members of their faculty attach the same importance to it.

The survey also produced data on the status of teaching of Total Quality in business and engineering programs, both undergraduate and graduate. Those responses are summarized in the following table.

Status of Total Quality - Undergraduate	All Deans	Bus. Deans	Eng. Deans
Total Interviews	515	355	160
Not currently including TQ principles/ methods in curricula and have not developed plans to do so	16%	12%	26%
Planning to include TQ as part of the curricula but have not yet implemented these plans	30%	30%	33%
TQ principles/methods are well integrated into a few (1-5) courses	44%	48%	34%
TQ principles/methods are well integrated into many (6-10) courses	3%	3%	3%
No Answer	7%	8%	4%

Status of Total Quality - Graduate	All Deans	Bus. Deans	Eng. Deans
Total Interviews	515	355	160
Not currently including TQ principles/ methods in curricula and have not developed plans to do so	12%	7%	21%
Planning to include TQ as part of the curricula but have not yet implemented these plans	20%	20%	21%
TQ principles/methods are well integrated into a few (1-5) courses	40%	47%	24%
TQ principles/methods are well integrated into many (6-10) courses	5%	6%	3%
Not Applicable	8%	7%	9%
No Answer	16%	13%	21%

These data suggest the following interpretations.

- Total Quality is finding its way into both business and engineering curricula. Penetration is at approximately 50% of business schools (both undergraduate and graduate programs) but is somewhat below that for engineering schools, especially at the graduate level.
- For those schools that have not yet integrated TQ into the curriculum, approximately 30% of the undergraduate programs (business and engineering) and approximately 20% of the graduate programs (business and engineering) are planning to do so.

This suggests that in the relatively near future a substantial portion of these programs will have reached the stage where Total Quality is taught in at least a few (1-5) courses. However, we can not tell from these data whether even the current coverage is in elective courses or in courses required of all students, what might be called "core" courses.

Earlier Total Quality Forums have produced much discussion of the need to "walk the talk" regarding Total Quality. That is, if we're going to insist that the topic be taught, it is only appropriate to expect that it be practiced in the school/college/university. Survey responses regarding practice are reported in the following table.

Status of Practicing Total Quality	All Deans	Bus. Deans	Eng. Deans
Total Interviews	515	355	160
TQ is not being practiced	44%	46%	42%
We are beginning to practice TQ in administrative areas	46%	43%	51%
Our practice of TQ in administrative areas is fairly advanced	3%	3%	4%
We are beginning to practice TQ in "academic areas" (curricula, research, etc.)	21%	20%	21%
Our practice of TQ in "academic areas" is fairly advanced	1%	2%	1%
No Answer	3%	3%	3%

These data suggest some progress but still a substantial opportunity to extend the practice of Total Quality.

Finally, the results from the questions concerning research on Total Quality are summarized in the following table.

Approximate Percent of Past Years Business/Engineering Schools Research Dollars Spend on Researching TQ	All Deans	Bus. Deans	Eng. Deans
Total Interviews	515	355	160
Zero	41%	34%	55%
1-5%	24%	23%	26%
6-10%	9%	11%	3%
11-15%	3%	4%	1%
16-20%	2%	3%	0%
21-25%	0%	1%	0%
Over 25%	1%	1%	1%
No Answer	21%	23%	16%

These survey responses indicate that Total Quality has not yet reached the point of being a prominent part of research allocations in business and engineering schools.

C. Needs of Employers

The Employers' Needs Working Council undertook to identify the extent to which employers required graduates educated in the principles of Total Quality. Their approach to answering this question contained two main elements. The Council identified 19 organizations that were known to have some level of practice of Total Quality. Representatives from these organizations were then interviewed to determine their need for graduates educated in the principles of Total Quality. These 19 organizations were primarily private business, but the set also included two governmental units and three organizations particularly focused on issues of quality improvement. This Council also studied the content of the TQM University Challenges that were conducted during 1992. The Challenges, which will be described briefly later in this report, involved faculty members from eight universities visiting five host companies to learn about those

companies' Total Quality practices. Ideas from these host companies were also used to formulate the summary that this Council compiled.

One interesting finding of this work is quite easy to state but somewhat surprising. Employers were found to want employees (hence graduates) who are knowledgeable about Total Quality, but few have integrated their expectations into recruiting practices. That is, these organizations did not indicate that recruiters who are visiting campus to do interviewing are either communicating this need on behalf of their company or using it as a basis for screening job applicants. This issue will emerge later in the discussion of recommendations.

Based on the interviews completed and other information assembled by the Council, they have formulated a profile of the elements of Total Quality that occurred most frequently and with the most emphasis. These key attributes of Total Quality for graduates seeking employment are listed below.

Employers' Needs: Knowledge of Total Quality

- Customer orientation
- Understanding of work as a process
- Systems perspective
- Commitment to improvement
- Fact-based decision making
- Active learner
- Practical knowledge/application of quality tools
- Team orientation

Since customer satisfaction occupies the central role in the Core Knowledge Council's definition of Total Quality, the notion of "customer orientation" in the list above simply confirms the importance of that concept. As the larger context of the Employers' Needs Council report indicates, this concept encompasses a commitment both to understand what constitutes customer satisfaction (in the customer's mind) and a commitment to meet those needs and requirements.

When the second through fifth elements of the list above are grouped together, one can observe interesting linkages. Viewing work as a process oriented around outcomes provides a focus for improving those outcomes. A systems perspective suggests conscious use of feedback loops to achieve

improvement, and the notion of fact-based decision making reflects Total Quality's roots in the scientific method.

Finally, the last three elements of the list express a need for a combination of knowledge, skill, and experiences with quality improvement concepts and tools. The notion of being an active learner involves being reflective and improvement-oriented regarding one's own processes. The last elements simply involve the use of known tools for quality improvement, frequently in teams formed to meet specific challenges.

Not surprisingly, this list reinforces and confirms the detail that the interested reader will find in the report of the Core Body of Knowledge Working Council.

V. Recommendations for Universities

The Working Council reports contain valuable information and suggestions for many constituencies — businesses, colleges and universities, individual teachers and researches, and so on. This section deals with portions of those reports that are directly relevant to the academic community. These conclusions and recommendations are combined here in one section containing material from several of the Working Councils. These statements will be presented under the headings listed below.

- Total Quality in Teaching and the Curriculum
- Research on Total Quality
- Practice of Total Quality in Universities

A. Total Quality in Teaching and the Curriculum

Increasing the attention to Total Quality in the curricula of business and engineering schools presents a special challenge for one simple reason. As the definition quoted in the preceding section indicates, Total Quality is broader in scope than any one of the typical disciplines found in a business or engineering school. TQ is inherently a cross-functional topic, involving as it does issues from product and process design, process planning and execution, marketing and customer relations, human resources, measurement, and additional areas. Faculty members in business and engineering schools, and other portions of the academic community as well, however, are specialists who tend to be organized by discipline. A large portion of curriculum design and development has normally been done by individual faculty members working alone or in small groups within individual disciplines. The task of building TQ into the curriculum thus suggests a need for new approaches.

The concept of the "customer" for the academic community raises issues that do not always arise when one considers a transaction in the more traditional manufacturing or service communities. Many academic units are today engaged in extensive and constructive discussions intended to create useful definitions of these customers and their needs. Whatever the precise terminology, business and engineering schools are increasingly concerned about meeting the needs of students enrolled in degree programs and of employers who will hire these graduates.

While recognizing that faculty members must respond to more than one constituency, a premise common to the work of the Working Councils is that these schools should address curricula to issues in the definition of Total Quality with the goal of meeting needs set out by the Employers' Needs Working Council. Business and engineering schools may well need to address different issues. Even two different business or engineering schools may find different agendas to be important to each of them. Three results desired for students can be found in the discussions of curriculum and employers' needs.

- ***Cover the breadth of Total Quality***
  Present the full content of the topic, rather than only some subset of the topics. Give attention to the full scope of the definition of Total Quality.
- ***Integrate Total Quality throughout the curriculum***
  Not only does Total Quality draw on elements of many disciplines, the interaction among these elements is an important factor in the effectiveness of implementation efforts. Serious efforts to improve customer satisfaction require some measurement system to assess progress. Efforts to increase employee involvement in the improvement process depend on orientation and training for the new expectations. And so on.
- ***Treat Total Quality as an approach to managing***
  Help students to understand that Total Quality is not simply something that is "added-on" after all other requirements have been met.

In the most advanced efforts that the Working Councils found, faculty were developing new teaching content and methods. They were also engaged in cross-functional or cross- disciplinary curriculum development.

The Curricula, Materials, and Programs Working Council surveyed 18 units that are at various stages of building Total Quality into their curricula. The Council also conducted a number of follow-up discussions to clarify practices.

Their purpose was to identify elements that appeared to be common to successful strategies. A summary of these findings appears in the six actions described below.

1. ***Get senior academic leadership***

   As has proven to be the case in TQ efforts in industry, senior leadership is an important predictor of success. In the academic community senior academic leadership stating vision, mission, and goals for the curriculum can be vital in getting the commitment to TQ to extend beyond islands in individual courses.

2. ***Involve stakeholders***

   If a school's educational process is viewed as a system, at least four important sets of stakeholders are apparent. University administrators and faculty are providers. Students and employers depend on the work of those providers. The Council found a number of creative ways in which interactions among representatives of these constituencies had contributed to progress in strengthening treatment of TQ in the curriculum.

3. ***Integrate Total Quality within and across programs***

   The point about integrating TQ within a given business or engineering program has already been suggested. In addition, at those universities where both business and engineering schools exist, there are opportunities to link both business and engineering education in creative ways.

4. ***Practice Total Quality Principles***

   The Council found instances where schools tried to give students multiple opportunities to experience Total Quality. Supplementing the direct delivery of the content, faculty members would practice TQ principles, such as continuous improvement, in the operation of a given course. In addition, practical opportunities might be created for students to work on or experience TQ improvement efforts.

5. ***Focus on customers in curriculum design***

   The Council found examples of application of a structured curriculum design process to the task of building TQ into the curriculum. These processes represented efforts to apply TQ concepts themselves to the task of curriculum development for Total Quality.

6. ***Develop forward-looking processes for curriculum change***

   If TQ teaching in universities merely tracks general current practice, the academic community will lag the needs of industry and will lag the best

practices in industry. As the academic community seeks opportunities to improve both the coverage and content of Total Quality, ideas will be generated for research and development of teaching materials that will then benefit the curriculum.

The Working Council identified some specific activities as "good practices" that it found during its interviews.

- Linkages across courses - coordination among concurrent courses and courses in series to reinforce TQ concepts
- Reinforcement experiences for students - group projects
- Courses and topics reflect quality principles and methodologies
- TQ required of all students - getting TQ beyond individual elective courses so that all students receive it
- Reflect employers' key needs - efforts to learn and respond to results that key employers (hirers) want from a given school

One of the important conclusions of the Curricula, Materials, and Programs Working Council was that a Resource Guide for the teaching of Total Quality should be developed. The various schools that want to build Total Quality into the curriculum are "customers" who must decide how to proceed. Faculties at these schools need access to materials that will help them to make this transition more rapidly. As a response to this need, the Resource Guide should contain bibliographical materials (topics and references), case studies and other teaching materials, and syllabi that describe approaches already underway. Access to such materials will assist schools that are in the early stage of TQ curriculum development to progress more rapidly than they would otherwise. Another aspect of the Resource Guide will be discussed later in connection with faculty development.

B. Research on Total Quality

The Total Quality Research Council built a valuable summary of the state of research on Total Quality, they considered the role of research on Total Quality, and they made recommendations designed to stimulate research efforts that will advance Total Quality concepts and practices. The latter issues will be presented later under the heading of actions of the Leadership Steering Committee.

The Council investigated global research activities, completed and underway, in foundations, consulting groups, study groups, laboratories, government, industry, and academia. Topics investigated included a wide range of issues that

could in some way be associated with the concepts, principles, and implementation of Total Quality. Their full report contains references and abstracts. Much of this work has appeared in publications intended for audiences other than the academic research community. The Council concluded that the work completed and underway is important and necessary, but it is not sufficient for a complete understanding and implementation of a "Total Quality Management System." Their report suggests a number of topics that are important for future research.

The Council's recommendations contain messages for the academic community plus recommendations designed to create the support necessary for the research effort. Issues from their report and subsequent discussions with Council members that related directly to universities will be summarized here.

1. ***Stimulate applied scholarship and research on Total Quality and recognize and reward this work in the academic community.***
   This issues deals with the climate for research on Total Quality in the academic community. Obviously, for faculty to engage in this research, the associated local incentives must exist. This calls for actions by administrators and senior faculty who manage the reward systems (promotion, tenure, and other elements) in the academic community. The actions sought in this regard are necessary to complement the actions that are being sought from the business community to provide support for this research activity.
2. ***Look to the criteria for the Malcolm Baldrige National Quality Award as a starting point for research issues, but also look beyond the Baldrige criteria for research topics of importance for the future.***
   The Baldrige criteria provide a framework that serves as a standard against which much of current practice is judged. The individual items and categories of the Baldrige Award suggest a number of opportunities for research. However, just as the administrators of the Baldrige Award conduct an annual improvement cycle for the criteria, the academic community should be looking for research issues that reach beyond the scope of the current criteria.
3. ***Establish academic/industry partnerships for research; expand existing partnerships to include Total Quality.***
   The opportunity for applied research focused on Total Quality is great. Mechanism such as industry grants, loaned executives, internships, Total

Quality education/training, cooperative (joint) research, consortiums and networks for research, and focused research programs all can help to create the formal and informal linkages that will stimulate research activity.

Not surprisingly, the notions about partnerships are totally consistent with the conclusions and recommendations of the Faculty Development Working Council. While the number of faculty members interested in Total Quality appears to be increasing, mechanisms are needed to hasten the rate at which faculty across many disciplines become interested, acquire knowledge, and become actively involved. Thus, approaches mentioned below under Recommendations for Businesses that will support faculty development also reinforce the Research Council's recommendations to stimulate research. This suggests that one of the linking thoughts emerging from the work of the entire set of Working Councils could be stated as follows.

> *The cross-functional nature of Total Quality provides a particularly good opportunity for the business and educational communities to create close and reinforcing connections among curriculum development, research effort applied to Total Quality, and advances in industry and academic practice of Total Quality.*

C. Practice of Total Quality in the University

The University Practice of Total Quality Working Council conducted direct interviews with some 22 institutions that are already embarked on efforts to implement Total Quality. From these interviews they created a summary of recommendations for colleges and universities. These appear below with brief discussion.

1. ***Get senior leadership involvement and commitment.***
   The practice of TQ needs to start with the leadership level of the college or university and a core group of faculty and staff who are convinced of the value of TQ. Senior institutional officers need to be brought into the process early.
2. ***Create a TQ Council and a TQ Champion.***
   The Council, including people at the highest level of the institution and in both the academic and administrative areas, should be formed to promote TQ and guide implementation efforts. The TQ Champion should be part of the Council and should serve as an individual focal point for TQ activities.

3. ***Plan for Total Quality and commit resources to it.***
   A well established strategic planning process should be closely tied to TQ initiatives. Resources should be committed to the implementations effort. This includes support for the TQ Champion, the TQ Council, and training (see below).
4. ***Invest in training.***
   Training is essential and use of both external and internal sources of advice and training has advantages. Training for members of quality teams should occur on a just-in-time basis.
5. ***Adopt measurement and assessment.***
   This recommendation is a companion to the recommendation for planning. Planning suggests setting goals. Evaluating performance against those goals calls for some approach to measuring progress and provides an opportunity to use periodic assessments to review both progress toward goals and also the processes that are in place to support existing plans.

One striking thing about these recommendations is that they show reassuring consistency with many of the "lessons learned" in industry during the implementation of Total Quality. Thus, senior academics who are currently living and driving these implementations are finding much in common with those portions of the business world that have been working toward these same goals.

VI. Recommendations for Businesses

Both the Employers' Needs Working Council and the Faculty Development Working Council made recommendations that are part of this Section. The common theme linking this material is a focus on activities sought by businesses in order to promote and support the research, curriculum development, and improved knowledge of graduates that is the purpose of this entire effort.

Section IV contains a summary of the process by which the Employers' Needs Working Council created a summary statement of the knowledge of Total Quality sought in graduates of business and engineering programs. In constructing this summary the Council made the interesting discovery that the companies helping to provide the statement of "needs" reported they had done little to incorporate TQ needs in their recruiting practices. This finding led that Council to consider the importance of communicating the needs of business with a consistent voice. In short, the recommendation to businesses is to reflect the

desire for TQ knowledgeable graduates in recruiting activities. One of the very effective ways of accomplishing this is for recruiters simply to ask interviewees what they have learned about Total Quality. As this occurs consistently over time, students will quickly carry the message to their faculty members about the message coming from the business community.

While reason exists to believe that interest in Total Quality is increasing among business and engineering faculty, this interest and involvement must expand substantially before extensive integration within the curriculum can be achieved. The Faculty Development Working Council was charged with recommending approaches that could enhance the preparation of business and engineering faculty members in Total Quality. As part of the survey described in Section IV above, this Council asked business and engineering deans to consider a range of approaches to this faculty development challenge. Ten different approaches were offered as options, ranging from creation of a Resource Guide through special seminars and conferences to faculty internships. Three approaches stood out in the responses.

- Industry executives on loan to schools
- Education/Business partnerships
- Resource Guide providing information for faculty development

Each of these approaches depends to some degree upon cooperation between the business and academic communities. Industry executives on loan could perhaps logically be done on a local or regional basis. Companies active in Total Quality could loan executives for joint teaching activities.

Education/business partnerships could take many constructive forms. One very interesting opportunity is to extend the good experiences that occurred in the TQM University Challenges in which substantial numbers of faculty members from the eight universities selected spent periods of up to one week at one of the five host companies. Robert Galvin, Chairman of Motorola, presented the idea of the TQM-University Challenge at Total Quality Forum 1991. He originally proposed to host one university at Motorola. Eventually, 27 proposals came from universities and four additional companies — IBM, Milliken, Procter & Gamble, and Xerox — agreed to host faculty and administrators from a total of eight universities. Based on those experiences the Faculty Development Working Council recommended that the concept be continued in 1993. This point will be addressed in the following section concerning actions of the Leadership Steering

Committee. A report summarizing these activities is expected to be prepared by people from Motorola.

Possibilities for education/business partnerships extend beyond activities on the scale of the TQM University Challenge. A number of additional ideas were presented on which individual companies and institutions can proceed. Several examples suggested by the Council appear in the list below.

- Invite faculty to study a business TQ experience (including successes and failures).
- Support progress in universities by providing training directly on campuses and by sharing corporate training courses and materials (videos, overheads, instructional aids, and the like).
- Assist colleges and universities to set up and administer their own faculty and employee development programs based on Total Quality.
- Provide internship opportunities for faculty and opportunities for student experiences with Total Quality.
- Assist in the development of Total Quality teaching materials.

Additional opportunities can no doubt be identified as discussions begin among education and business people. The general objective is to initiate and sustain exchanges of information that will enhance faculty understanding of applications and implementation.

The idea for a Resource Guide as presented by the Faculty Development Working Council complements the concept described under the same name for curriculum development in Section V for curriculum development. The objective would be to create a repository of information from businesses that would support faculty development. Valuable materials would include corporate quality plans, training plans and materials, summaries of company implementation, specific projects or cases, and other items of this sort. This should all be viewed as supplementary to materials that support curriculum development. A recommendation that combines these ideas is part of the report of actions of the Leadership Steering Committee in the following section.

Both the Faculty Development Working Council and the Research Working Council recommend that businesses include research in the activities that these partnerships seek to enhance. Businesses can provide input on research proposals and projects. Education/business discussions during the formulation of research projects could be extremely productive. Many research projects will depend crucially on access to business information for research studies.

Academics might have great interest, for example, in studying processes for implementing Total Quality. Projects could involve case writing in an individual company or the gathering of data across a number of companies. Finally, financial support for research is addressed in the following section with other actions taken by the Leadership Steering Committee.

VII. Actions of the Leadership Steering Committee

The Leadership Steering Committee met at The Procter & Gamble Company on October 5, 1992, to consider the reports of the Working Councils and to consider several recommendations for action by the Committee itself. The Committee also reaffirmed its belief that Total Quality is a topic of great importance for business and engineering education because of the role it can play in improving the value that a business provides to its customers. The Committee noted that the survey results (summarized above) indicated an increasing importance attached to the topic of Total Quality in the education community. However, those same survey results also indicated that considerable action will be required in the academic community to bring the topic to the status of thorough coverage, let alone a central role, in business and engineering curricula. The reports of the Working Councils identify a number of specific actions that should be pursued by both the education and business communities. The Leadership Steering Committee also concluded that a need still exists for a stimulus at a national level.

The Committee endorsed the findings and recommendations of the Working Councils and agreed to champion them during and following Total Quality Forum 1992. Each of the Working Councils will discuss its findings at the Forum and each Council report will appear in the published summary of the Forum. In addition, of course, those reports provided a set of recommendations for action that the Leadership Steering Committee considered. Taken together they are intended to advance the status of Total Quality in teaching, research, and practice in the education community and to increase the rate at which progress is made in these regards. Four specific areas of action by the Leadership Steering Committee are listed below.

- Expand the base of education/business partnerships to build on the success of the TQM University Challenge.
- Stimulate research on Total Quality.

- Promote the creation of a Resource Guide that will support curriculum and faculty development.
- Provide structure(s) for the continuing work by the Leadership Steering Committee and the working councils following Total Quality Forum 1992 in November.

Each of these areas of action is described more extensively in the following material.

A. Expand the Base of Education/Business Partnerships

The Leadership Steering Committee agreed to promote extension of the concept of the TQM University Challenge. The companies that served as hosts during 1992 will continue the relationships that have been established and they will also promote additional relationships. These companies and other members of the Leadership Steering Committee will also seek involvement of additional companies to serve as hosts.

The Committee also noted that education/business partnerships could take a range of forms that might include a number of local working relationships linking colleges and universities and area businesses. Indeed, the notion of partnerships could be as informal as one faculty member working with one manager on a focused project or as formal as a multi-day program arranged by a company for a large group of faculty and administrators, with any number of possibilities in between these arrangements. These working relationships can and should add to the activity in one or more of the following: faculty development, research on Total Quality (input to research topics, advice on research proposals, access to information for research), development of TQ teaching materials, and student or faculty experiences with applications or implementation.

B. Stimulate Research on Total Quality

The Leadership Steering Committee concluded that research on Total Quality must proceed in the academic community in conjunction with curriculum and faculty development. Indeed, research is recognized as a way to contribute to and sustain both curriculum and faculty development. Successful expansion of research activity on Total Quality requires both the access that has been discussed above and support in the academic community through the reward and recognition systems of institutions (promotion and tenure). Increased research activity also requires financial support in the form of (summer) salary

support and funding for the doctoral students who will both contribute to the research and experience the benefits of involvement in Total Quality early in their careers.

Acknowledging this need for financial support, the Leadership Steering Committee agreed to support the formation of a pool of research funding and the creation of a process for administration of research grants. The Committee endorsed the concept of shared support for research with financial support being provided by the business community and an appropriate foundation (or foundations) and in-kind support being provided by universities. The intention is to create a pool of funding to cover an initial period of three years.

While detailed guidelines remain to be created, the Committee tentatively endorsed giving priority to projects that have some or all of the following characteristics.

- Applied scholarship in Total Quality
- Cross-functional topics
- Multi-disciplinary research teams
- Experiential content
- Commitment to dissemination of results

C. Promote Creation of a Resource Guide

The preceding discussion has identified the need for a central repository of information that would serve two sets of needs — one for curriculum development and one for faculty development. The possibility for constructive overlap of the types of materials needed caused the Leadership Steering Committee to agree to support the creation of one Resource Guide to be operated on a self-supporting basis.

The Leadership Steering Committee will propose an approach to developing and operating a Resource Guide.

D. Provide for the Continuing Work of the Leadership Steering Committee

The Leadership Steering Committee agreed to continue its work beyond Total Quality Forum 1992. A Total Quality Forum will be hosted in 1993 by Motorola with additional corporate sponsorship. The Working Council Co-Chairs will meet at the end of Total Quality Forum 1992 to consider the agenda for future work and to draft a proposal for consideration by the Leadership Steering Committee.

VIII. Conclusion

Activities since Total Quality Forum 1991 have accomplished a number of things. The Working Councils themselves have enlarged the number of individuals working at a national level to move Total Quality to a larger presence in university curricula. They have also increased the level of joint business/education activity related to Total Quality. The Councils' reports in combination provide a more substantial base of information about activities already underway, identify a number of good practices, and indicate many actions that can be pursued in both the education and business communities.

By its commitment to continue providing a stimulus at the national level, the Leadership Steering Committee is sending a consistent, affirming message about the importance of Total Quality in the United States. Building on the notion of continuous improvement, the Committee supports increased teaching, study, and use of Total Quality.

Finally, continued and increased efforts are needed in diverse partnerships linking the education and business communities. This central theme initiated by David Kearns at Xerox in the 1989 Forum has been reemphasized by Mr. Artzt and Mr. Pepper of Procter & Gamble through the design of the Leadership Steering Committee, support for the six Working Councils, plans for Total Quality Forum 1992, and commitment to support the work that will follow. The Committee's wish is to see this next Forum clarify directions for action and energize increasing numbers of people in widespread efforts on Total Quality. The 1992 Forum should serve as the springboard for enhanced commitment in the academic community and a rapid increase in the preparation of graduates who are knowledgeable about Total Quality.

Appendix
The Leadership Steering Committee
(As of October 5, 1992)

John F. Akers
Chairman of the Board, IBM

Paul A. Allaire
Chairman and Chief Executive Officer, Xerox

Edwin L. Artzt
Chairman of the Board and Chief Executive,
The Procter & Gamble Company

John V. Byrne
President, Oregon State University

Livio D. DeSimone
Chairman of the Board and Chief Executive Officer, 3M

Meyer Feldberg
Dean, Graduate School of Business, Columbia University

Christopher B. Galvin
Senior Executive Vice President and Assistant Chief Operating Officer, Motorola

Roger Milliken
Chairman and Chief Executive Officer, Milliken

C. Warren Neel
Dean, College of Business Administration, University of Tennessee at Knoxville

John E. Pepper
President, The Procter & Gamble Company

Frank H.T. Rhodes
President, Cornell University

James D. Robinson III
Chairman and Chief Executive Officer, American Express

William R. Showalter
Dean, School of Engineering, University of Illinois

Donna E. Shalala
Chancellor, University of Wisconsin at Madison

Robert C. Stempel
Chairman, General Motors Corporation

Charles M. Vest
President, Massachusetts Institute of Technology

John A. White
Dean of Engineering, Georgia Institute of Technology

B. Joseph White
Dean, School of Business Administration, University of Michigan

John P. Evans
Professor of Business Administration, The University of North Carolina at Chapel Hill, and Advisor to the Leadership Steering Committee

References

1. E. L. Artzt, in The Total Quality Forum - A Report of Proceedings (Cincinnati, The Procter & Gamble Company, 1992).
2. M. Dertouzos, R. Lester, R. Solow, et al. *Made in America: Regaining the Productive Edge* (Cambridge: MIT Press, 1989).
3. Murrin, Thomas J., statement at meeting of the Leadership Steering Committee, October 5, 1992.
4. R. B. Reich, *The Work of Nations - Preparing Ourselves for 21st Century Capitalism* (Alfred A. Knopf: New York 1991).
5. L. C. Thurow, Head to Head - *The Coming Economic Battle among Japan, Europe, and America* (New York: William Morrow and Company, Inc., 1992).
6. "Report of the Core Body of Knowledge Working Council," October 5, 1992.
7. "Report of the Employers Needs Working Council," October 5, 1992.
8. "Report of the Curricula, Materials, and Programs Working Council," October 5, 1992.
9. "Report of the Faculty Development Working Council," October 5, 1992.
10. "Report of the Total Quality Research Working Council," October 5, 1992.
11. "Report of the University Practice of Total Quality Working Council," October 5, 1992.

Core Body of Knowledge Working Council: Perspectives on Total Quality

Working Council Membership

Co-Chairs

John Rampey
Vice President, Management Development, Milliken & Co.

Harry V. Roberts
Professor, Graduate School of Business, University of Chicago

Members

Don P. Clausing
Professor, Massachusetts Institute of Technology

A. Blanton Godfrey
Chairman & CEO, Juran Institute, Inc.

William A. Golomski
President, W.A. Golomski & Associates

H. Thomas Johnson
Retzlaff Chair in Quality Management, Portland State University

Carla O'Dell, Ph.D.
American Productivity and Quality Center

Douglas Park
Director, Boise Cascade Corporation

Richard J. Schonberger
Schonberger and Associates

A. William Wiggenhorn
President, Motorola University

Contents

Overview and Summary

Introduction

1. What is Total Quality?
2. Broad Perspectives on TQ
3. Ideas of Total Quality
4. One List of Principles of Total Quality
5. Roots of Total Quality
6. What is New About Total Quality?
7. Actual and Potential Impact of TQ on Academic Areas in Business Schools (Schonberger)
8. Actual and Potential Impact of TQ on Academic Areas in Engineering Schools (Clausing)
9. Skeptics
10. Issues in Implementation of TQ

Appendix A Selected Background Readings on TQ

Core Body of Knowledge Working Council: Perspectives on Total Quality

Overview and Summary

The working assumption of Total Quality is that continual organizational improvement, small and large, is always possible and is necessary for long term survival. Opportunities for improvement are recognized primarily by continuing reexamination of *all* existing constraints on the way that work is done. This reexamination is focused on all organizational processes, and it is guided by three basic ideas, which have to be sold to all employees:

1. Orient all efforts towards delighting customers and removing waste in (or constraints on) internal processes.
2. Stress team effort at all levels inside and outside the organization, including cooperative efforts with suppliers and customers.
3. Use data and scientific reasoning to guide and evaluate improvement efforts, and to hold the gains from past improvements.

These three ideas, when applied systematically, lead to management practices that are very different from traditional practices. The new practices are so appealing that many people, upon first encountering them, will insist that they have been following them all along.

As you will see from our report, these ideas of Total Quality lead to much more than meets the eye on first glance. And they pose a profound psychological challenge: they say that, no matter what we have done in our lives up to the present moment, we must be prepared to find that we can do enormously better. This is gratifying in the sense that improvement is always gratifying. But it also suggests that what we have done in the past is going to look bad in the light of present knowledge. For many of us, that is hard to accept.

The detailed management tactics of Total Quality go beyond traditional optimization within fixed constraints — which is the core of the analytical

component of MBA curricula — to shoot at ever moving improvement targets by relaxing or eliminating constraints. Since there is no end to opportunities to relax or eliminate constraints, improvement is never ending.

Total Quality tactics do not follow as deductive consequences of the broad Total Quality strategy just outlined, of any axiom system yet formulated, or of any set of principles from existing academic disciplines. Although different practitioners of Total Quality share many common ideas and practices, they follow somewhat different tactics. This in part reflects the fact that many basic disciplines — from statistics to industrial engineering, from behavioral science to management science, from accounting to value engineering, from economics to systems theory — have contributed good ideas to Total Quality.

This diversity of Total Quality tactics poses a challenge both in formulating a "core body of knowledge" and in translating any such core into specifications for curriculum or targets for research. Any brief summary will fail to do justice to all the tactical variations and to the continuing evolution and improvement of the tactics themselves.

We have therefore called our Report, "Perspectives on Total Quality". Some appreciation of these perspectives is necessary to avoid superficial fixes to current curricula, ill-advised research strategies, or frustration in the application of Total Quality to university administration. Unfortunately, coverage of these perspectives has led to a longer report than we originally aimed at. The following quick overview may help in orientation towards the report.

1. *Our basic definition of Total Quality. It is not as concise as we would like, but it shows that, in spite of the many tactical variations, there are a few core concepts of Total Quality:*

Total Quality is a people-focused management system that aims at continual increase of customer satisfaction at continually lower real cost. Total Quality is a total system approach (not a separate area or program), and an integral part of high-level strategy; it works horizontally across functions and departments, involves all employees, top to bottom, and extends backwards and forwards to include the supply chain and the customer chain. Total Quality stresses learning and adaptation to continual change as keys to organizational success.

The foundation of Total Quality is philosophical: the scientific method. Total Quality includes systems, methods, and tools. The systems permit change; the philosophy stays the same. Total Quality is anchored in values that stress the dignity of the individual and the power of community action.

2. *What all students need to learn, which will help in thinking about needed changes in core MBA courses:*
   - To define quality on customers' terms.
   - To manage for continuous improvement in quality.
   - To leverage investment in quality.

   This requires that students learn to manage an organization as an integrated system of interrelated parts; in particular, they must learn concepts like the following:
   - What a system is and how it operates.
   - Why variation matters and how it can be reduced, including basic statistical tools, management of suppliers, analysis of processes.
   - How to design products and services that satisfy customers' latent needs.
   - How to obtain measurements that allow employees to assess the effects of their performance on other system elements and on the system as a whole.
   - How to encourage value-adding participation.
   - How to build commitment to organizational goals.
3. *Specialized areas from which Total Quality is constructed, which may help in developing elective courses and formulating research strategies:*
   - Quality control and related ideas from Statistics.
   - Just-in-Time and related ideas from Operations Management.
   - Employee involvement and related ideas from Behavioral Science.
   - Total customer satisfaction, customer-driven measurements, and related ideas from Marketing.
   - Benchmarking — learning from others, inside and outside the organization.
   - Development and deployment of quality planning throughout an organization, and related ideas from Organization and Policy.
   - Concurrent engineering for rapid development of new products and services.
   - Replacement of top-down control through accounting by leadership of top management in improving customer-focused processes.
   - Attempts to define operational standards for organizational excellence, as illustrated by the criteria for the Malcolm Baldrige National Quality Award.

- Process management and improvement as a philosophy and a methodology.

4. *Problems in the practical implementation of Total Quality:*

Total Quality is in one sense a highly democratic system, but it requires dedicated and informed leadership from senior management, leadership that is aware of the obstacles to successful implementation. Total Quality goes beyond specific improvements, however desirable these may be, to the transformation of organizations and organizational cultures from what they are today to something very different.

Introduction

We assume that faculty members and administrators who use this report will have some minimal exposure to Total Quality (TQ) ideas and terminology, such as that provided in Mary Walton's *The Deming Management Method*, but we have tried to make our presentation as self-contained as possible. A brief guide to further reading is provided in Appendix A.

When we first assumed our task, it seemed natural to aim for a unified, formal, polished, comprehensive, authoritative, definitive synthesis of the Core Body of Knowledge underlying Total Quality.

As we gave more thought to the needs of our immediate customers — the other five Working Councils — we realized that they, in turn, have the task of providing guidance to their customers (our "downstream" customers) — college and university faculty and administrators — as to how to make effective use of TQ for teaching, research, and administration. These downstream customers need to be introduced to relevant ideas, concepts, and tools. They need information that will help them to decide whether TQ has solid content or is merely a superficial fad, or even a repackaging of what they already know.

These customers should understand that TQ is not a monolithic, static body of knowledge but a rapidly developing group of related ideas that offer, in our judgment, great promise for higher education. The ideas need to be conveyed without extravagant claims and without any pretense that one current synthesis can be regarded as orthodox and the others as heretical.

Therefore, rather than to attempt a synthesis, we have decided to provide an informal series of perspectives on TQ that would bring out the important ideas in

a form that would permit faculty members and administrators to make an informed evaluation of them.

Members of our Working Council have a few disagreements — mostly minor — about the TQ ideas set forth in this report, and there is some duplication among the perspectives we present. We have tried not to suppress real differences of view nor to inflict needless repetition. Although individual members of our Working Council would place differing emphases on the various perspectives, there are very substantial commonalities among the perspectives, and we believe that collectively they present an accurate picture of TQ as it exists today.

In addition to members of our Working Council, many others have contributed to this report. In some instances the individual contributions are so specific and distinctive that we have identified names at appropriate points in the text, but, named or not, we are grateful to all who have helped.

1. What is Total Quality?

Total Quality (TQ) is a people-focused management system that aims at continual increase of customer satisfaction at continually lower real cost. TQ is a total system approach (not a separate area or program), and an integral part of high-level strategy; it works horizontally across functions and departments, involves all employees, top to bottom, and extends backwards and forwards to include the supply chain and the customer chain. TQ stresses learning and adaptation to continual change as keys to organizational success.

The foundation of Total Quality is philosophical: the scientific method. TQ includes systems, methods, and tools. The systems permit change; the philosophy stays the same. TQ is anchored in values that stress the dignity of the individual and the power of community action.

This definition of "Total Quality" suggests that customer satisfaction — even customer delight — is a useful definition of "quality". More fully this means (as Golomski puts it): "meeting the perceived needs of the customer over the likely use or ownership of the product or service". (In addition to customer satisfaction, Total Quality also includes satisfaction of needs and fulfillment of talents of all individuals in the system.)

Customer satisfaction has many dimensions, of which conformance to specifications* is only one. In addition, Schonberger distinguishes:

- performance*
- quick [some suggest "timely"] response
- quick change expertise
- features*
- reliability*
- durability*
- serviceability*
- aesthetics*
- perceived quality*
- humanity
- value

* The eight starred items on the enumeration above are taken from a listing by David Garvin. Schonberger points out that the four unstarred items are not just variations or extensions of the first eight: they are basic and vital in their own right. Thus quality, considered carefully, includes more than has been traditionally subsumed in the term, certainly much more than conformance to specifications. Conformance to specifications is desirable — essential when the specifications are aimed at achieving customer satisfaction and fulfilling aspirations of everyone in the system.

What is in an Acronym?

"TQ" for "Total Quality" is only one of many acronyms used to label the management system that we have just described. Some of these other acronyms are widely used, especially "TQM" for "Total Quality Management" and "CQI" for "Continuous Quality Improvement". Other acronyms are specific to given companies or organizations. Three comments are in order:

- The substance that underlies the acronym is what matters.
- Labeling a given organization's activities by one of these acronyms does not itself demonstrate that the organization is implementing the management system we are discussing.
- All the current acronyms could pass out of use without affecting the usefulness of the management system here described. An organization could implement the concepts without using any acronym at all.

We interpret TQ to embrace all the ideas and activities set forth in this report, whatever acronyms may be associated with them.

2. Broad Perspectives on TQ

In this section we view TQ from several broad perspectives. First, we present a crisp view from the perspective of management or business. Then we look at the major sources of TQ ideas, that is, to the "constituents" of TQ, which will make it easy to see where academics can look to relate TQ to existing fields. From this we turn to a statement and brief discussion of Deming's famous Fourteen Points, which express one formulation of the management philosophy of TQ, a formulation that defines the kind of organizational culture conducive to successful application of TQ. We amplify salient aspects of such cultures and how they differ from many current cultures.

We then present Clausing's view of TQ from the perspective of a tree structure. Next comes Johnson's view of TQ as a management paradigm that challenges currently accepted paradigms. Since the concept of "process" is basic to TQ, we then present O'Dell's overview of processes and subprocesses that exist or need to be defined in organizations. This is followed by Finster's explanation of the relation between processes and functions. Customer satisfaction is central, so we present Park's view of TQ in terms of achievement of customer satisfaction. Golomski shows how TQ looks to four broad approaches for solving problems and making improvements, and we discuss these briefly. Then Landel views TQ in terms of areas of management. Next, we present a summary of the major criteria of TQ as set forth by the Malcolm Baldrige National Quality Award. Finally, we present a Japanese perspective on Total Quality based on a presentation by Yoshinori Iizuka at the Xerox Quality Forum of 1989.

A Management Perspective (Kelsch)

What is Total Quality and why is it important?

- It is an approach to management that focuses on fully satisfying customers and their requirements. It emphasizes the prevention of errors, which can reduce costs at the same time that customers are being satisfied.

- For organizations to be competitive in a global economy, they must become more effective, efficient, and responsive in providing products and services that meet their customers' needs.

What is required to achieve this Total Quality?

- The pursuit of Total Quality is a never-ending journey that requires:
  - ➢ Fundamental and permanent changes in the way organizations are managed.
  - ➢ Empowerment of everyone in the organization to act to satisfy the customers of their work.
- Because the change is so pervasive, it must be led by senior executives; responsibility for Total Quality cannot be delegated. Thus a major change in the personal behavior of senior executives is required.
- In particular, senior executives must create the environment and assure that the means are provided to improve the key work processes of the organization.

Why is it called "Total Quality"?

- Because it must focus on driving out errors in everything we do, striving to understand and fully to satisfy the needs of final customers. Everyone works in a chain that supports final customers. The links in the chain are described as internal customers who must receive error free work in order to produce error free work for the final customer.
- For example, the training department must help to build the knowledge and skill for people to know how to repair equipment so that it operates according to the designed performance.

What are some practical principles of Total Quality?

- Fully satisfy customer-driven requirements.
- Superior results through process improvement.
- Continuous improvement by prevention.
- Error free work reduces cost.
- Employee involvement and empowerment.
- Leadership by example:
  - ➢ Vital few objectives.
  - ➢ Supportive environment.
  - ➢ Management by fact.

TQ as a Union of Diverse Constituents

TQ embraces several broad constituents that can and should be mutually reinforcing. The following list is incomplete; it is intended only for concreteness.

1. ***Quality control***, applied throughout the organization, both for production and service activities; for example:
   - Inspection
   - Statistical Process Control
   - Elementary management tools: e.g., flowcharts, cause-and-effect analysis, check sheets, questionnaires, Pareto analysis, time series plots, scatter plots, histograms, stratification.
   - Sophisticated statistical tools such as design of experiments and intervention analysis.
   - Systematic approaches to quality improvement, such as Plan-Do-Check (or Study)-Act (PDCA); the Diagnostic Journey and Remedial Journey; Kume's Q Story; and Focus-PDCA.
   - "Zero defects" or "Zero variation": focusing attention on better ways to conform to quality specifications, in part by motivation not to produce defects.
   - Robust design of processes and products.
   - Reliability
2. ***Just-In-Time (JIT)*** and many related ideas for the simplification, elimination of waste or removal of constraints, and building flexibility and fast response into all processes and into the design of new products and processes. JIT is applicable to service processes as well as manufacturing processes. The world is now moving beyond JIT to a broader concept sometimes called "time-based management", with emphasis on elimination of waste time — largely queue and rework time. Basic concurrent engineering (see point 8.) can be thought of as the application of the same principles to product development.
3. ***Employee involvement:*** harnessing the knowledge and creative powers of all employees, individually and in small teams; usually aims at a complete transformation of organizational culture and has major implications for organizational structure. Training and education are essential. "Drive out fear of making suggestions for change, trying out new methods, being

blamed for problems that are inherent in the system, or losing one's job because of quality improvements." Some typical elements:

- Empowerment, the authority to plan and do the work you are capable of doing
- Self-managed work teams, an example of empowerment
- "Market in" or "market pull" orientation
- Learning organization
- Customer managed organization
- Personal quality improvement

4. ***Total customer satisfaction:*** searching out ways better to serve all customers, internal as well as external, even going beyond "satisfaction" to "delight". Emphasizes customer-driven measurements, as defined by customers' wants and needs.
5. ***Benchmarking:*** "steal and improve on any good idea that isn't proprietary, *whatever the source of the idea*". Get rid of the "not-invented-here" syndrome. Potential problem: customer wants may not be fully met by anyone in the market.
6. ***Stretch objectives:*** rapid deployment *throughout an organization* of efforts to lower error-rates, cycle-times, and costs for key processes by establishing core competencies and removing constraints on improvement. Requires identification of customer/supplier relations, internal and external, and process mapping. Stresses rates of improvement rather than absolute attainment, thus making possible valid comparisons of progress between different sub-units of an organization. Underlying this approach is the basic idea that continuous improvement can embrace large improvements as well as small ones: illustrations are Schaffer's "Breakthrough Strategy", Hammer's "Reingineering", and General Electric's "Workout".
7. ***Hoshin planning.*** Systematic procedures for achieving the aims of traditional "Management by Objectives" (MBO), but relating objectives to what can realistically be achieved and inviting participation of all levels of the organization in setting objectives. Relies heavily on data on customer needs, competitors' capabilities, and internal process capabilities. Often uses the "Seven Management Tools" — such as affinity diagrams — in helping groups to reach creative consensus. (See discussion of the Management Tools in the summary of Iizuka's contribution at the end of this section.)

8. ***Simultaneous engineering, concurrent engineering:*** cooperation for development of new products, with emphasis on fast and frequent prototyping and other ideas for reducing the cycle time of new product development. Translation of customers needs into new products and processes is aided by Quality Function Deployment (QFD) and Taguchi engineering ideas about robust design. All involved in the development are empowered to come in the process early, start anticipating and planning their roles, and making suggestions that may help other departments.
9. ***The new management:*** replacement of top-down control through accounting numbers by leadership of senior management for improvement of processes with the ultimate aim of better bottom-line results. Harmonizes with such elements as Hoshin Planning and Quality Function Deployment, but can arise independently. Leads to major changes in organizational structure, flattened organization charts, reduced emphasis on types of control, such as remote top-down control using accounting numbers, that encourage tampering with processes and manipulation of appearances rather than improvement of processes.
10. ***Operational standards for organizational excellence,*** as illustrated, for example, by the criteria of the Malcolm Baldrige National Quality Award (see brief summary later in this section).
11. ***Process management and improvement:*** A process is a series of activities by which inputs are converted to outputs. The activities are definable, repeatable, measurable, and predictable. Process management is a methodology that attempts continually to increase effectiveness and efficiency of processes. This requires detailed analysis of the processes to reduce cycle times and defects and to improve customer satisfaction. By defining and documenting processes we can better understand:
    - What we do
    - How we link together
    - What our dependencies are
    - Which activities are redundant and therefore unnecessary
    - How we can simplify what we do
    - How to continuously improve

The keys of the success of process management are: management commitment and involvement, identification of critical success factors, and a cross-functional focus. (See also *Process Model of TQ: Enterprise Model (O'Dell).*)

There is reason to expect continuing enhancement, evolution, and integration of the various constituents of TQ. TQ is evolutionary. The TQ practiced in business in 1997 will have evolved substantially from the TQ we are describing in 1992. In particular, the Total Quality methods that are successful in making initial improvements today, when there is much "low-hanging fruit" to be picked, will be extended to include comprehensive management systems that are now to be glimpsed only in companies that have been pursuing TQ for decades rather than years. See, for example, Richard Tabor Greene, *World Quality*, manuscript, 1991.

In this context it may be useful to speak in terms of "First Generation Total Quality (or "Basic Quality"), "Second Generation Total Quality" (or "In-Depth Quality), and so on. Most U.S. organizations today are in the First Generation, with emphasis on systematic deployment and implementation of quality improvement projects throughout the organization, concurrent engineering for new product development, and the like. Greene's book looks into the Second Generation and beyond. So too does Peter M. Senge's *The Fifth Discipline: The Art & Practice of The Learning Organization*, Doubleday/Currency. Greene emphasizes organizational strategies, while Senge probes deeply into concepts, attitudes, and skills that individuals and teams can develop in order to transform the entire organization. Senge's book deals at length with issues underlying what Deming calls "A System of Profound Knowledge"; see Henry R. Neave, *The Deming Dimension*, SPC Press, Inc., Chapter 18. Another interesting book that looks beyond current TQ is John N. Warfield, *A Science of Generic Design: Managing Complexity Through Systems Design*, Volumes I and II, Intersystems Publications, 401 Victor Way - No. 3 Salinas, CA 93908.

A current reference that discusses many current initiatives that carry beyond First Generation Quality is John A. Byrne, "Management's New Gurus", *Business Week*, August 31, 1992. This reference illustrates an interesting development: the emergence of TQ seems to have stimulated fresh management theorizing that, unlike much theorizing in the past, has been directed to, and tried out for, concrete improvement in organizational performance. This has been true for decades in Japan; it is now happening in the United States. A possible explanation for this gratifying development is that the TQ emphasis on removal of constraints applies just as well to management theorizing as to special organizational improvements.

Deming's Fourteen Points (As stated in Out of the Crisis)

1. Create constancy of purpose toward improvement of product and service, with the aim to become competitive and to stay in business, and to provide jobs.
2. Adopt the new philosophy. We are in a new economic age. Western management must awake to the challenge, must learn their responsibilities, and take on leadership for change.
3. Cease dependence on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place.
4. End the practice of awarding business on the basis of price tag. Instead, minimize total cost. Move toward a single supplier for any one item, on a long-term relationship of loyalty and trust.
5. Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decrease costs.
6. Institute training on the job.
7. Institute leadership. The aim of supervision should be to help people and machines and gadgets to do a better job. Supervision of management is in need of overhaul, as well as supervision of production workers.
8. Drive out fear, so that everyone may work effectively for the company.
9. Break down barriers between departments. People in research, design, sales, and production must work as a team, to foresee problems of production and in use that may be encountered with the product or service.
10. Eliminate slogans, exhortations, and targets for the work force asking for zero defects and new levels of productivity. Such exhortations only create adversarial relationships, as the bulk of the causes of low quality and low productivity belong to the system and thus lie beyond the power of the work force.
11. a. Eliminate work standards (quotas) on the factory floor. Substitute leadership.
    b. Eliminate management by objective. Eliminate management by numbers, numerical goals. Substitute leadership.
12. a. Remove barriers that rob the hourly worker of his right to pride of workmanship. The responsibility of supervisors must be changed from sheer numbers to quality.

b. Remove barriers that rob people in management and in engineering of the right to pride of workmanship. This means, *inter alia*, abolishment of the annual or merit rating and of management by objective.

13. Institute a vigorous program of education and self-improvement.
14. Put everybody in the company to work to accomplish the transformation. The transformation is everybody's job.

Deming came to Total Quality from statistics. Statistical thinking is behind the fourteen points listed above, but Deming's view extends beyond techniques to the organizational culture in which Total Quality is applied, because he has seen clearly that statistical or other techniques cannot be successful in a poor organizational culture. Selwyn Becker has provided an interesting statement of the organizational culture that is a prerequisite for, and consequence of, systematic implementation of Total Quality ideas:

- Responsibility and independence at all organization levels (Contrast: Responsibility and independence at department head levels or higher)
- Employees encouraged to innovate, take risks (Contrast: Incentives geared to avoid failure)
- Organization goals: mission clear to all (Contrast: Goals not explicit, no mission statement)
- Coordination and cooperation across units encouraged and enabled (Contrast: Units concerned with own performance; disregard other units' performance)
- Managers support subordinates, give credit (Contrast: Managers take all the credit, criticize subordinates)
- Few formal rules, coordination by face-to-face interaction (Contrast: Coordination and control of employees by use of rules)
- Members identify with organization and its goals (Contrast: Managers identify first with own goals, then department goals, then organization goals)
- Rewards foster group cooperation, striving for overall organization goals (Contrast: Rewards based on individual performance primarily)
- Employees encouraged to express and resolve conflicts openly (Contrast: Conflicts are suppressed, settled by fiat)
- Communication dictated by the work to be done (Contrast: Communication restricted to formal reporting pattern)

TQ Defined (Described) in Terms of a Tree Structure (Clausing)

A concise, top-level definition (description) of TQ is:

> *Management by facts applied by teams to improve processes (as perceived by customers) with high expectations.*

This definition can be thought of as the top element in a tree structure, or as the left-most (unindented) element in an indented structure, or the top-level icon in a Macintosh computer. We can double-click on this icon, and it opens up into five subsidiary icons:

- Management by facts
- Teams
- Process improvement
- Customer driven
- High expectations

These could also be displayed as the second level of a tree structure or the first degree of indentation in an indented structure. Then we can go to the next level by double-clicking on Teams, for example, which would lead to salient points about teams. The objective is to have a structured description, represented at the highest level by the very concise statement, which can be remembered.

TQ as a Management Paradigm (Johnson)

TQ is a management paradigm, a philosophy of management, a way of thinking about business that differs dramatically from the paradigm that has guided most American business practice since the 1950s. TQ is also an emerging body of theory concerning business behavior; it provides categories for organizing field observations (John Dewey); it is a basis for deriving predictive hypotheses.

- The key feature of this paradigm is the idea that work is a process and that a business is a system of processes that is aimed at exceeding customer expectations profitably.
- Two keys to customer satisfaction:
  - ➢ continuously reduce variation in customer-defined outcomes of all processes;
  - ➢ couple all processes into linked flows and continuously reduce the time work takes to go from idea to satisfaction.
- Technical changes (having to do with computers and microprocessors) have put the customer, not the producer, in charge of markets. To

succeed with the customer in charge, a business must be quick to adapt to changes in customer expectations. Hence workers must be able to learn and change processes quickly in response to these changes.

- Competing in a TQ environment requires companies to make information about customer expectations and process capabilities available in real time to workers who run processes and meet customers. This contrasts with competing with instructions and feedback controlled at the top of an organization.
- A key theme in TQ is the need to focus companies on a larger vision that creates what Deming calls "joy in work" and "pride of workmanship". Companies should focus not only on stockholders but on customers, employees, suppliers, and other members of the society affected by a business.

Process Model of TQ: Enterprise Model (O'Dell)

Our definition of TQ as a customer-focused management system brings out the process-orientation that drives most current quality improvement. The TQ tools must be tied to the business itself and not to a separate activity called "improvement". TQ strategy and tactics should be employed in all the core processes. (Recall the definition: a process is a series of activities by which inputs are converted to outputs.) The activities are definable, repeatable, measurable, and predictable. Process management is a methodology that attempts continually to increase effectiveness and efficiency of processes.

The core processes and subprocesses of organizations can be viewed in terms of tasks that must be accomplished in almost all organizations:

- Understand Markets and Customers (Customer Information Gathering and Analysis; Competitive Analysis; Quality Function Deployment). The process of measuring customer attitudes and market reactions to existing and new product or service ideas.
  - ➢ Determine customer needs and wants
    - ✦ Conduct qualitative assessments
      conduct customer interviews
      conduct focus groups
    - ✦ Conduct quantitative assessments
      develop and implement surveys
    - ✦ Predict customer purchasing behavior

- ➢ Measure customer satisfaction
  - ✦ Monitor satisfaction with products and surveys
  - ✦ Monitor satisfaction with complaint resolution
  - ✦ Monitor satisfaction with communication
- ➢ Monitor changes in market or customer expectations
  - ✦ Determine weaknesses of product/service offerings
  - ✦ Identify new innovations that are meeting customer needs
  - ✦ Determine customer reactions to competitive offerings

- Develop Vision and Strategy (Hoshin Planning; Visioning; Quality Policy Deployment; Strategic Quality Planning). The process of defining a business or organizational concept, designing an organization to implement the concept, and setting overall organizational goals.
  - ➢ Monitor the external environments
    - ✦ Analyze and understand competition
    - ✦ Identify economic trends
    - ✦ Identify political and regulatory issues
    - ✦ Assess new technology innovations
    - ✦ Identify social and cultural changes
    - ✦ Understand ecological concerns
  - ➢ Define the organizational strategy
    - ✦ Select relevant markets
    - ✦ Develop long-term vision
    - ✦ Formulate business unit strategy
    - ✦ Develop overall mission statement
  - ➢ Design the organizational structure and relationships between organizational units
  - ➢ Develop and set organizational goals
- Design Products and Services (Design for Manufacturability; DFA; Engineering). The process of conceiving, designing, developing, modifying, and testing new products or services to satisfy customer wants based on the organization's vision and strategy.
  - ➢ Translate customer wants and needs into product and/or service requirements
  - ➢ Create product/service life cycle plan

- Develop product/service concept and plan
  - Develop quality, cost, and timing targets
  - Develop and integrate leading technology into product/service concept
- Design, build, and evaluate prototype products or services
  - Document design specifications
  - Develop engineering drawings
  - Apply for patents or copyrights
- Prepare for production
  - Develop and test prototype production process or service methodology
  - Design and order necessary material, tooling, and equipment
  - Install and verify process or methodology
- Monitor product/service performance and make refinements as needed
  - Add new products/services
  - Improve existing products/services
  - Eliminate quality/reliability problems
  - Eliminate outdated products/services
- Test effectiveness of new or revised products or services
- Implement new product engineering techniques
  - Conduct concurrent engineering
  - Develop detail product specifications
  - Implement value engineering
  - Use CAE/CAD/CAM and simulation techniques
- Manage the product/service development process
  - Develop appropriate customer and supplier interactions
  - Ensure appropriate cross-functional organizational interactions
  - Identify and secure resource requirements
    - Budget cash requirements
    - Identify people requirements
    - Develop information needs
    - Identify capital equipment requirements
    - Identify facility/property requirements
    - Determine material requirements
  - Check and evaluate

- Market and Sell. The process of communicating product or service benefits to existing or potential customers and taking orders from customers.
  - ➢ Market products or services to relevant customer segments
    - ✦ Develop advertising strategy
    - ✦ Develop market messages to communicate benefits
    - ✦ Estimate advertising resource and capital requirements
    - ✦ Identify specific target customers and their needs
    - ✦ Sell products or services
    - ✦ Respond to customer requests for quotations or proposals
    - ✦ Negotiate terms
  - ➢ Process customer orders
    - ✦ Accept orders from customers
    - ✦ Enter orders into production and delivery process
- Produce and Deliver (Statistical Process Control; DFE). The process of fulfilling specific customer product or service needs starting with an order and ending with delivery to the customer.

  For manufacturing oriented organizations:
  - ➢ Plan for and acquire necessary resources
    - ✦ Acquire capital goods
    - ✦ Hire employees
    - ✦ Obtain materials and supplies
    - ✦ Obtain appropriate technology
  - ➢ Convert resources into products
    - ✦ Develop and adjust production processes (for existing products)
    - ✦ Schedule production
    - ✦ Handle materials
    - ✦ Make product
    - ✦ Package and store the product or service
    - ✦ Load out the product
  - ➢ Make delivery
    - ✦ Schedule delivery with customer
    - ✦ Schedule delivery vehicle to be used
    - ✦ Develop and adjust routing conventions
    - ✦ Load, go and unload

- Install (if specified)
- Manipulate documentation

➢ Manage the process

- Document and monitor order status
- Control and reconcile inventories
- Assure quality and inspect
- Schedule maintenance
- Do maintenance
- Monitor environmental constraints
- Develop community relations
- Encourage improvement initiatives
- Develop employee training

For service oriented organizations:

➢ Plan for and acquire necessary resources

- Hire employees
- Obtain materials and supplies
- Obtain appropriate technology
- Acquire capital goods

➢ Develop human resources skills

- Define skill requirements
- Identify and implement training
- Monitor and manage skill development

➢ Delivery service to the customer

- Identify specific customer needs
- Translate customer needs into service to be provided
- Provide the service to specific customers

➢ Manage the process

- Schedule actual delivery of the service
- Provide quality assurance
- Schedule human resources

• Invoice and Service Customers (Customer Satisfaction Measurement; Cycle Time). The process of providing after-sales service to an existing customer such as invoicing, field service and support, maintenance, warranties and repairs, and customer inquiries.

➢ Bill the customer

- Develop, deliver, and maintain customer billing

- Invoice the customer
- Provide information on usage, products, or bills

➢ Provide after-sales service
- Provide in the field service
- Handle warranties and claims
- Provide follow-up service to customers

➢ Respond to customer inquiries
- Respond to information requests
- Manage customer complaints

• Manage, plan, monitor, and administer. The collection of processes needed for organization support to ensure that the organization stays on track with its vision and strategy.

➢ Measure performance

➢ Develop finance and accounting systems

➢ Develop detailed budgets
- Forecasting
- Manage resource allocation decisions

➢ Manage external relationships
- Communicate with share holders
- Manage government relationships
- Build lender relationships
- Develop public relations program
- Interface with the board of directors

➢ Manage information systems

➢ Manage human resources

➢ Manage legal and ethical issues

The above treatment of core processes and subprocesses gets into enough detail that one can identify many specific opportunities for improvement in any organization; for example, the subprocess, "Apply for patents or copyrights", was substantially improved at Motorola.

Function Analysis, Quality Deployment, and Various Versions of Quality Function Deployment (Finster)

Function analysis is a professional field that identifies and analyzes the functions of an organization in order to improve them. From the view of function analysis, the above outline by O'Dell *(Process Model of TQ: Enterprise*

Model) identifies key functions of an organization. For example, "understanding markets and customers" is a key function of an organization that would include as subfunctions "determine customer needs and wants", "measure customer satisfaction", and "monitor changes in market or customer expectations". Each of these can again be broken down further into finer subfunctions. The process of identifying an organization's functions and breaking these functions into finer and finer subfunctions is called function analysis or function deployment. Historically its roots can be found in the Value Analysis/Value Engineering schools initiated in the 1940's that also analyze the costs and values attributed to a function.

Processes are definable, predictable repeatable actions that can be flowcharted. Processes are particular actions that deliver functions. For example, a key function of every organization is "to understand markets and customers"; hence every organization needs a process by which this is accomplished. From industry to industry and organization to organization, there are many different processes for delivering a given function.

If the thinking and methodology of TQ is "deployed" into the processes that deliver the functions of an organization, it is said by the Japanese "Total Quality Control" (TQC) school that the organization practices "quality function deployment in the narrow sense". This should not be confused with the "quality function deployment" of TQ that includes matrix tools like the "house of quality". The TQC school regards the latter as simply part of quality deployment, which includes also customer-driven cost deployment, reliability deployment, and technology deployment. The TQC school refers to "quality function deployment in the broad sense" as the full integration of "quality function deployment in the narrow sense" with "quality deployment".

References:

Akao, Yoji, ed., (1990) *Quality Function Deployment: Integrating Customer Requirements into Product Design*, Productivity Press, Cambridge, MA.

This book was originally titled "Quality Deployment" and was translated as "Quality Function Deployment" to correspond to the TQ terminology.

Akyama, Kaneo (1991), *Function Analysis: Systematic Improvement of Quality and Performance*, Productivity Press, Cambridge, MA.

TQ Viewed from the Perspective of Customer Satisfaction (Park)

Definition of Total Quality: TQ is a people-focused management system that emphasizes cost effective satisfaction of customers.

Goal: Delighted customers (but at a profit).

Delighted in what way?: Customers' perception of whether quality and value of products and services fulfill their expectations.

Who is the customer?: It is important to focus on the common downstream customer in addition to the next customer in the customer-supplier chain (both external and internal). It is also important to view the employees of an enterprise as customers of management/leadership.

Why is value important?: It is important that we give the customers what they want at the lowest possible "Cost of Use" to maximize both the customers' and the suppliers' *profitability*. Eliminating *waste* in systems is the key.

How are these perceptions measured?: A Customer Satisfaction Measurement system.

What influences these perceptions?: Both process data and customer experience with internal processes such as:

- Manufacturing processes
- Delivery processes
- Sales and order entry processes
- Pricing processes and other accounting processes that influence value
- Billing processes
- Other service processes
- Communications processes
- Decision making processes
- Problem solving/prevention processes

What knowledge and skills should be taught for use in improving these processes and perceptions?:

- Leadership
- Culture change (Schein and Horniman)
- SPC — Statistical Process Control
- JIT — Just-In-Time (Schonberger and others)
- DOE — Design of Experiments (Taguchi, Box, and others)
- Concurrent engineering

- Survey sampling (Deming and others)
- Team processes
- Recognition (Thompson, Anderson, and others)
- Communication
- Empowerment/Employee involvement
- ABC/ABM (Activity based costing, management). [Here there is divergence within the Working Council; Johnson regards ABC as a part of the old paradigm: "activity management" is antithetical to "process improvement".]
- Measurement systems design
- QPD (quality policy deployment, management by policy)
- QFD (quality function deployment)
- Benchmarking (Camp)
- Integration with all planning processes
- Integration with compensation systems (Doyle and Lawler)

(The list is not intended to be complete. It will change over time as new tools are developed and old tools are improved.)

Four Pillars of TQ (Golomski)

- Technology/Equipment
- Systems/Management
- Behavioral/Sociological
- Quantitative/Data-Based

Golomski thinks of his first pillar — technology/equipment — not as a part of TQ but as an alternative, and very important, way to increase competitiveness. This might include the use of magnetic character recognition in check sorting; the use of bar codes in grocery stores, warehouses, and transportation; numerically controlled machine tools and robots in manufacturing; touchtone telephones in university registration; and computer aided engineering and computer aided design.

Golomski's four broad categories have been fleshed out as follows by Jack L. Huffman, Director, Quality Management Programs, School of Business, Management Institute, University of Wisconsin-Madison:

- Technology/Equipment Approach to TQM
  - ➢ Computers
  - ➢ Automation

- ➢ Robotics
- ➢ Overnight Delivery
- ➢ Communications Devices and Systems
- ➢ New Materials
- ➢ New Processes
- ➢ Others

- Systems/Management Approach to TQM
  - ➢ Policies
  - ➢ Procedures
  - ➢ Problem Identification and Solution Systems
  - ➢ Problem-Solving/Process-Improvement Approaches
  - ➢ Mistake Proofing
  - ➢ Documentation Systems
  - ➢ Cost of Quality and Non-Quality Systems
  - ➢ Customer Focus Systems
  - ➢ Systems to Clear the Way for People To Do Their Jobs Better
  - ➢ Contemporary Resource Allocation Systems
  - ➢ Others
- Behavioral/Sociological Approach to TQM
  - ➢ Training, Education and Development
  - ➢ Group/Team Approaches
  - ➢ Utilization of Each Person's Talent and Creativity
  - ➢ Empowerment and Belief in Human Worth
  - ➢ Self-Directed Work Groups
  - ➢ Non-Traditional Reward Systems
  - ➢ Focus on Internal Customers
  - ➢ Others
- Quantitative/Data-Based Approach to TQM
  - ➢ Inspection/Auditing Strategies
  - ➢ Data Gathering Approaches
  - ➢ Precontrol
  - ➢ Statistical Process Control
  - ➢ Design of Experiments
  - ➢ Taguchi Methods and Quality Function Deployment
  - ➢ Advanced Statistical Approaches
  - ➢ Others

Landel's Outline of TQ Management Areas and Important Techniques

- Executive Leadership
  - ➢ Visioning Leadership
  - ➢ Principles & Culture Development
  - ➢ Goals and Objectives Setting
  - ➢ Quality Policies
- Performance Management
  - ➢ Strategic Quality Planning System
  - ➢ Measurement Systems
  - ➢ Reward and Recognition Systems
  - ➢ Communications Systems
  - ➢ Project Management Systems
  - ➢ Assessment Approaches (ISO/Baldrige/Deming)
  - ➢ Supplier Partnership Management
- Human Resource Management
  - ➢ Employee Involvement Work Systems and Work Climate
  - ➢ Team Effectiveness
  - ➢ Training and Development Systems
  - ➢ Individual Performance Appraisal and Feedback
  - ➢ Management of Change
- Product/Process/Design
  - ➢ Principles and Concepts of Quality Engineering
  - ➢ Robust Design Methodology
  - ➢ Design for Reliability
  - ➢ Design for Manufacturing
  - ➢ Quality Function Deployment
- Improvement Methodologies/Techniques
  - ➢ Process Analysis & Improvement Model (PDCA)
  - ➢ Fundamental Tools
  - ➢ Basic Statistics
  - ➢ Statistical Process Control
  - ➢ Statistics for Experimental Design
  - ➢ Process Mapping
  - ➢ Value Analysis
  - ➢ Cycle Time Analysis
  - ➢ Benchmarking

Criteria for the Malcolm Baldrige National Quality Award (Major categories only)

1. Leadership
2. Information and Analysis
3. Strategic Quality Planning
4. Human Resources Development and Management
5. Management of Process Quality
6. Quality and Operational Results
7. Customer Focus and Satisfaction

The Japanese Way of TQC (Total Quality Control)

For a Japanese perspective on Total Quality, we summarize highlights of a presentation by Yoshinori Iizuka, The University of Tokyo, at the Xerox Quality Forum in 1989. Note that "Total Quality Control" (TQC) corresponds closely to "Total Quality Management" (TQM), a common American term for Total Quality.

Introduction

1. What is Japanese TQC (Total Quality Control = Company-Wide Quality Control)?
   - A business management system that puts Quality Assurance (QA) in its core.
   - All departments and all personnel, under the leadership of top management, should apply Management by Policy (see below).
2. What is Quality Assurance?
   - Activities that give confidence to customers that products and services will provide positive satisfaction.
3. "Total" in three meanings:
   - Participation by every department
   - Participation by all personnel
   - Improvement of everything

Leading Principles

1. Concept of Quality
   - Quality = User's Satisfaction
   - The Next Processes are Our Customers
2. Concept of Management
   - PDCA cycle: plan, do, check, and act
   - Recurrence Prevention Stressed over Immediate Action

3. Management by Facts
4. Respect for Humanity
    - Company thinks of its employees' growth, while employees think of their company's prosperity.
    - Volunteerism/Self-Management
    - Participation by everybody

Management by Policy (Hoshin Kanri)

1. Sets Today's Target and Future Direction
2. Steps:
    - Establish mid-term and long-term policy.
    - Determine the annual presidential policy.
    - Deploy the presidential policy in each department.
    - Carry out policies to achieve the targets.
        - ➢ Check whether action items assigned to each department are adequate.
        - ➢ Carry out the action items in each department.
        - ➢ Check progress during the year and, if necessary, change the plan or the way of implementing it.
    - Analyze the results at the end of the year.
        - ➢ Analyze the results in each department.
        - ➢ Collect the results of each department and find substantial problems of the company.
        - ➢ Address the problems during the next annual policy or during mid-term/long-term policy.
3. Key Points in Hoshin Kanri:
    - Select important items.
    - Repeat PDCA cycle at proper intervals.
    - Stress the process of achieving objectives.
    - Participation by all personnel.
    - Cooperation of all departments.
    - Improve Hoshin Kanri process itself.

Quality Assurance System

1. What Should We Do as Quality Assurance Activities?
    - Systematic activities to provide confidence in quality for users.
        - ➢ Establish standard procedures to achieve quality.
        - ➢ Evaluate the adequacy of those procedures.

- ➢ Monitor whether the standards are observed.
- ➢ Check the quality of final products.

- Systematic activities for processing quality troubles
  - ➢ Before-sales servicing — Instruction for users
  - ➢ After-sales servicing — Prompt and accurate processing of complaints
  - ➢ Problem-solving — Preventive action

2. Quality system elements
   - Management responsibility, quality system policy, organization, quality manual, audits, etc.
   - Product planning
   - Design/development
   - Procurement
   - Production preparation
   - Production
   - Inspection
   - Packaging and storage
   - Sales and distribution
   - Installation and operation
   - Technical assistance and maintenance
   - Processing of complaints and claims
   - Quality documentation and records
   - Education and training

QC Story — Problem Solving Procedure

1. Problem: define the problem clearly.
2. Observation: investigate the specific features of the problem from a wide range of different viewpoints.
3. Analysis: find out what the main causes are.
4. Action: take action to eliminate the main causes.
5. Check: make sure the problem is prevented from recurring.
6. Standardization: eliminate the causes of the problem permanently.
7. Conclusion: review the problem-solving process and plan future work.

Seven QC Tools

Prof. Ishikawa said, "95% of the quality problems in the workplace can be solved with the Seven QC Tools."

1. Check Sheet/Checklist: makes it easy to collect and use data.

2. Pareto Diagram: helps to find the "vital few" problems.
3. Histogram: tells the manner of dispersion of data.
4. Cause & Effect Diagram (Ishikawa Diagram): arranges the cause-and-effect relations.
5. Stratification: helps to find differences between data.
6. Scatter Diagram: shows correlation between two variables.
7. Graph & Control Chart: helps to find a specific feature behind the data and to analyze and control the process.

Seven Management Tools for QC

1. Affinity Diagram: specifies the problems to be solved by integrating language data with mutual affinity.
2. Relation Diagram: clarifies the structure of a complicated and entwined problem by means of arrangement.
3. Tree Diagram: traces the relationship between the target and measures and clarifies the structured elements of the object and their interrelations.
4. Matrix Diagram: arranges items in a column and a row of a matrix, showing the relation and its strength between these elements, and thereby obtains viewpoints for solving a problem.
5. Matrix-data Analysis (= Principal Components Analysis)
6. PDPC (Process Decision Program Chart): predicts the future in the developing stage of an event and thereby leads it to a desirable result.
7. Arrow Diagram (= PERT: Program Evaluation and Review Technique): makes the optimum scheduling to carry out a plan and control its progress effectively.

Statistical Methods

1. Fundamental Techniques
   - Pareto Analysis
   - Histogram
   - Scatter Diagram
   - Control Chart
2. Test and Estimation
3. Design of Experiment
4. Regression Analysis
5. Sampling Theory
6. Multivariate Analysis
7. Reliability Theory

Other QC Techniques

1. Quality Deployment: breakdown of required quality
2. Quality Table: relation between what is required and what is needed to satisfy the requirements
3. FMEA (Failure Mode & Effect Analysis): prediction and prevention of quality troubles
4. FTA (Fault Tree Analysis): failure analysis prediction of failure rate
5. DR (Design Review): milestone review by specialists from various fields
6. OR (Operations Research): optimization
7. IE (Industrial Engineering): work study
8. VE/VA (Value Engineering/Value Analysis): cost reduction

Steps to Introduce and Promote TQC

1. Understanding of TQC and consensus within the company
   - Crisis consciousness
   - Survey of other companies' instances
   - Proposition to top management
   - Declaration by top management
   - Diagnosis by external consultants
2. Promotion organization and promotion plan
   - Appointment of an executive in charge of promoting TQC
   - Establishment of an organization for promoting TQC
   - TQC promotion plan
3. Education and spread of the concepts of TQC
   - Education plan
   - Dispatching executives, managers, and staff to external seminars
   - Internal courses for staff and hourly workers
   - Top management must listen to lectures by external consultants or professors or other top managers who have successfully implemented TQC
4. Improvement within departments
   - Diagnosis and consultation by external consultants
   - Practice of problem solving
   - Improvement of "Day-to-day management"
   - QC Circle activities

5. Close cooperation among departments
   - Standardization
   - Information system
   - "Cross-Functional Management"
   - "Management by Policy"
   - Diagnosis by president
6. Establishment of total management system
   - Systematic implementation of Quality Assurance
   - Systematic implementation of Profit Management

The Role of Top Management for Quality Promotion

1. Clear policy for TQC promotion
2. Personnel administration for Quality promotion
3. Budget for TQC education and training
4. Deploy quality function to each department
5. Quality Diagnosis/Audit
6. Change work habits from "immediate remedy" to "recurrence prevention"
7. Don't criticize your subordinates on problem occurrence itself, but instead, praise them for disclosing their own problems.

Organization for Quality

1. In addition to QA Department and the inspection function, need Corporate TQC Promotion Committee and Divisional TQC Promotion Committees
2. The role of the TQC Promotion Staff
   - Selecting good external consultants
   - Being a good catalyst, proving good advice and support
   - Horizontal deployment to other departments
   - Organizing TQC mass meetings
   - Persuading anti-QC persons, dealing with resistance

Education and Training

1. QC starts with education and training and ends in education and training
2. For all personnel from top management to line workers in accordance with the required job
3. External courses as well as internal courses
4. Contents (as a minimum)
   - Basic concepts (quality, management, facts, "respect for humanity", etc.)
   - Problem-solving techniques (QC story, Seven tools, etc.)
   - Quality assurance system

5. Order of education
    - Opinion leaders/key persons
    - Top management
    - Managers, staff
    - Supervisors
    - Line workers
6. Lecture contents of QC Executive Course (JUSE, Japanese Union of Scientists, and Engineers) (5 day course, 34 hours)
    - Quality Control and Corporate Management
    - Statistical Techniques for Executives
    - Quality Control at Product Planning/Design Stage
    - Quality Control at Manufacturing/Purchasing Stage
    - Quality Control in Sales/Service Department
    - Administration of Quality Control Activities
    - Quality Assurance System
    - Case Study: Company-Wide Quality Control in Deming Prize Winner Company
    - Group Discussion
    - Summary of Group Discussions

Getting Rid of Paper QC

1. Problem Solving
    - QC begins with confession
    - QC story
    - Repeat "Why" five times
2. Day-to-day Management
    - "Day-to-day management" first; then "Management by Policy"
    - Don't be hasty in introducing "Management by Policy" without training in how to solve problems.
3. Slow and Steady
    - The first stage of promoting TQC is at least three years.
    - Introducing TQC leads to changing all employees' way of thinking about their job.

QC Circles

1. General Principles
    - QC Circle: a small group that performs quality control activities voluntarily within the same workplace.

This small group (as a part of the company-wide quality control activities) works continuously on self-development, mutual development, and control and improvement within the workplace. All members actively contribute and use quality control techniques.

- The basic idea behind QC Circle Activities
  - ➢ Contribution to the improvement and development of the enterprise
  - ➢ Respect humanity and build a worthwhile-to-live-in and happy, bright workplace
  - ➢ Display human capabilities fully and eventually draw out infinite possibilities
- The Ten Fundamentals of QC Circle Activities
  - ➢ Self-development
  - ➢ Voluntariness
  - ➢ Group Activities
  - ➢ Participation by all
  - ➢ Utilization of quality control techniques
  - ➢ Activities closely related to the workplace
  - ➢ Enhanced and never-ending activities
  - ➢ Mutual Development
  - ➢ Creativity
  - ➢ Quality consciousness, problem consciousness, and improvement consciousness

2. Notes on QC Circle Activities
   - Promotion and support organizations consisting of both managers and staff
   - Section manager's role is vital
   - Introducing QC Circles without active managerial involvement in TQC activities will be fatal to the activity. QC Circle members will feel "used" by management and will not believe that management is truly committed to TQC.

Misunderstandings about Quality and Japanese TQC

1. Improvement in quality leads to an increase in cost.
2. Strict inspection is required to improve quality.
3. Quality control is the manufacturing department's job.
4. Japanese products are of high quality because of QC Circle activities.

5. Japanese products are of good quality because of good workers.
6. TQC is equal to QC circle activities.
7. In order to promote TQC, top management has only to create a QC department and support its activities.
8. SQC is an old technique and TQC is a new one.
9. TQC takes immediate effect.
10. TQC is almighty.

3. Ideas of Total Quality

To flesh out the perspectives presented in Section 2, we now spell out ideas that are widely accepted by advocates of Total Quality.

Fundamentals

- Consistent orientation toward pleasing customers, internal or external. Quality is thus customer defined.
- Visualization of an organization as a system of interdependent processes, each with suppliers and customers, that can be mapped by flow charts and process manuals.
- Goals for all processes, manufacturing or service: high quality and productivity, in a state of statistical control (predictable in terms of probability), short cycle time, small lot sizes, low inventories, fast changeovers, just-in-time processing, total preventive maintenance (TPM), low costs, and elimination of mistakes and waste.
- Measurement and scientific method, including statistics, applied for improvement of processes throughout the organization. ("In God we trust; all others must bring data.")
- Aggressive but realistic improvement targets for all products, processes, and services. Improvement can be continuous (many small changes) and discontinuous (occasional major breakthroughs), and it should be never ending: it's always possible to do better.
- "Robust new product design": a major objective is to create products that will still perform well when used under unfavorable conditions.
- Retain the gains from past improvements. (This is the traditional American "Quality Control" or "Quality Assurance", which is only one component of TQ.)

Human Resources and Organization

- Continuing education and training; expansion of job scope and enrichment of careers.
- Teamwork: work teams (or QC circles) within departments and special improvement teams from different departments and organizational levels, for improving cross-functional cooperation and solving inter-departmental problems. Teams can often accomplish more than their individual members could do on their own.
- Provide opportunities and incentives for all employees to buy into organizational goals: employee involvement.
- Employment stability.
- Flat organization charts; simple, structured, documented designs for all products and processes.
- Alignment of quality objectives of each subunit of a larger organization.
- Automation only when economically beneficial.
- Incentives, rewards, and recognition for implementation of TQ.
- New product design should bring together, early in the process, all who will ultimately be concerned with the product's success.
- All know their place in the system and how they contribute to customer satisfaction.

Implementation

- Learn from mistakes and problems; don't try to fix blame. (Ask "Why?", not "Who?".) Assessment of blame for quality failures is counter-productive; root causes must be found and corrected. (Juran's work has shown that in most instances the root causes of problems are inherent in the systems established by management that cannot ordinarily be fixed by front-line employees.)
- No constraint on improvement should be accepted as sacrosanct. If necessary, think in terms of a "clean sheet of paper". Remove constraints that create unnecessary variation, thereby reducing delay and unneeded output.
- Avoid tradeoffs by removing constraints. (For example, one can aim at both higher quality and lower costs, or reduced budgets and increased services.)

- Emphasis on long-term cooperative, not adversarial, relations between suppliers and customers, internal or external.
- When unions are present, emphasis on management/union cooperation rather than adversarial relations.
- Benchmarking to find best current practices, inside or outside the organization.
- Improvement can be a systematic process, often entailing "projects" aimed at specific problems or opportunities for improvement. A project proceeds in a well defined, step by step, sequence of activities. Often projects are implemented by cross-functional, cross level teams or by operator teams (e.g., QC Circles) within departments, but sometimes dedicated individuals can do the job.
- Rapid diffusion of best current practice; cloning and spin-off.
- Information systems that contribute to all the above, but no record keeping for the sake of record keeping.

Differences of Opinion about TQ

There is broad consensus among Total Quality adherents on most of the ideas above. Given the breadth of TQ and the varied backgrounds of its adherents, there are surprisingly few differences of opinion. The most widely discussed of these differences center on the following points from Deming's list, but even here, as we suggest, the differences are easy to exaggerate.

> *"10. Eliminate slogans, exhortations, and targets for the work force asking for zero defects and new levels of productivity. Such exhortations only create adversarial relationships, as the bulk of the causes of low quality and low productivity belong to the system and thus lie beyond the power of the work force." [They also create waste when there are adversarial relationships, because they focus on results, not means. It is counterproductive to chase targets with no map.]*

There is general agreement that exhortation by itself is not consistent with TQ, but most companies implementing TQ make some use of slogans and exhortation. They also have Vision and Mission Statements that affirm constancy of purpose, Deming's Point One.

> *"11b. Eliminate management by objective. Eliminate management by numbers, numerical goals. Substitute leadership." [This entails constancy of purpose and a clear sense of values and processes.]*

Many TQ concepts can be interpreted as "management by objectives", but these differ substantially from traditional, top-down management by objectives. Our view is that traditional MBO needs to be converted into Hoshin planning or management by policy (see Section 2), which is MBO made effective by two major additions to conventional MBO:

1. Deployment of objectives throughout the organization by catchball planning, often using a variant of Quality Function Deployment
2. On-line quality control by the application of PDCA (plan-do-check-act).

These two improvements overcome the major problems with MBO and make the process effective.

Total Quality advocates place great emphasis on the process by which work is done. This is in reaction to the American tradition of ignoring the process, or considering the process too narrowly. However, it is possible to place emphasis too exclusively on the process, ignoring the "product", the outcome from the work. This too will lead to failure. Success comes from a coordinated emphasis on product and process. Objectives are bad only when they are unilaterally imposed on others with little consideration for the process by which they can be accomplished. Work needs objectives or else it will wander off into too many byways that are not productive in meeting the needs of the customers.

> *"12b. Remove barriers that rob people in management and in engineering of the right to pride of workmanship. This means, inter alia, abolishment of the annual or merit rating and of management by objective." [Breeds competitiveness, not cooperation.]*

Incentive and compensation systems used by companies implementing TQ vary widely, but many of them use some form of merit ratings or performance appraisals. Peter Scholtes has amplified the Deming position by suggesting that it is possible to "unbundle" into separate tasks the various functions that make up the performance appraisal: pay, promotion, feedback to employees, identification of training needs, etc. Scholtes argues that information and feedback should be based on key process characteristics, not individual performance; it should tell how processes can be improved. His central idea is that performance can be appraised only for systems, not for individuals or teams.

4. One List of Principles of Total Quality (Schonberger)

General

1. Get to know the next and final customer
2. Get to know the competition
3. Dedicate to continual, rapid improvement in quality, cost, response time, and flexibility

Design and Organization

4. Cut the number of components or operations and number of suppliers to a few good ones
5. Cut the number of flow paths (where the work goes next)
6. Organize product- or customer-focused linkages of resources Operations
7. Cut flow time, flow distance, inventory, and space along the chain of customers
8. Cut setup, changeover, get-ready, and start-up time
9. Operate at the customer's rate of use (or a smoothed representation of it)

Human Resource Development

10. Develop human resources through cross-training (for mastery), continual education, job switching, and multiyear cross-career reassignments
11. Develop operator/team-owners of products, processes, and outcomes

Quality and Problem-Solving

12. Make it easier to produce or provide the product without error (total quality)
13. Record and retain quality, process, and problem data at the workplace
14. Ensure that line people get first crack at problem-solving — before staff experts

Accounting and Control

15. Cut transactions and reporting; control causes not costs

Capacity

16. Maintain and improve present resources and human work before thinking about new equipment and automation

17. Automate incrementally when process variability cannot otherwise be reduced
18. Seek to have plural instead of singular workstations, machines, and cells or flow lines for each product or customer family

Marketing

19. Market and sell your firm's capability and competence

5. Roots of TQ

More than any other general approach to management, TQ has diverse origins. The ideas outlined above have come from many sources: academic and practical disciplines, "gurus" (mostly not from universities), and companies. Popular history is oversimplified. Deming and Juran do indeed stand out as major players who were listened to in Japan in the early and middle 1950s and who can claim assists on the many goals scored by Japanese companies ever since. But many other major and minor players and a few key organizations have contributed. The following sketch gives some idea of the diversity of contributions to TQ.

- TQ owes much to Frederick C. Taylor and "Scientific Management" — "there's a one best way to do anything, and an expert can figure out what it is" — which traces back to the turn of the century and has much influenced both business practice and the discipline of industrial engineering.

  Taylor himself was well aware that there was more to management than Scientific Management. TQ includes important elements that were not a part of Scientific Management, and is not simply "Taylorism" in a new guise, although it has been described with some justice as "democratic Taylorism".
- Statistics and statistical thinking, including Fisher's design of experiments; Shewhart/Deming's statistical process control; recent contributions to experimental design, time series analysis, and intervention analysis by Box and others; Ishikawa's "seven basic statistical tools"; managing with the aim of reducing variation.
- Taguchi's engineering and statistical tools for the design of robust products and processes, that is, products and processes that function well under adverse as well as ideal circumstances.

- Applied Behavioral Science
  - ➢ Individual motivation (employee involvement)
  - ➢ Small group research (effective problem-solving teams)
  - ➢ Importance of "stretch goals"
  - ➢ Importance of education and training
  - ➢ Charismatic leadership concepts from sociology
  - ➢ Principles of organizational change from sociology
  - ➢ There is no best way, but not any way will do.
  - ➢ Work by Japanese academics working with engineer/practitioners.
- Organizational theory (e.g., increased span of control, flattened organizational structure, leaderless working teams).
- Management theory (e.g., Deming, Drucker, Ford, Ishikawa, Juran, Ohno, Shingo).
- Increased customer orientation (Drucker, Levitt).
- Never-ending improvement. It is not useful to think in terms of "one best way"; when we think we have found it, we can always improve. Ordinary people as well as experts can contribute to improvement. The development of this concept is distinctly Japanese.
- Just-in-time production, quick changeovers, work cells, and other ideas of manufacturing engineering, all of which carry over to service processes. A single company, Toyota, has pioneered many of these ideas, which have become so widely accepted that they are well represented in the newer texts on Operations Management.
- Value analysis and value engineering, which has been especially important in Japan.
- The process of problem-solving can be structured; for example:
  - ➢ Shewhart/Deming PDCA (plan-do-check-act) cycle, which relates to thinking of John Dewey and C.I. Lewis).
  - ➢ Juran's diagnostic and remedial journeys, and holding the gains.
  - ➢ FOCUS-PDCA Problem Solving Approach.
  - ➢ Many variations on the above.
- Reconsideration of the role of accounting, particularly whether it can provide data useful for improvement of processes (Johnson/Kaplan). [Johnson says No; Kaplan says Yes].

- Continuing developments by Japanese companies and other organizations, including the Japanese Union of Scientists and Engineers (JUSE); for example, "Quality Function Deployment (QFD)" and Hoshin Planning, the "Seven Management Tools", QC Circles, and Taguchi's ideas about robust design of products to reduce variability of performance under a wide range of conditions encountered in actual use.
- American quality professionals, under the general banner of the American Society for Quality Control (ASQC), have made many contributions to what are sometimes called the Quality Sciences. Some indication of the scope of this work is reflected in the encyclopedic, *Juran's Quality Control Handbook*, now in its fourth edition.
- With some exceptions, the mainstream of university business and engineering research has thus far contributed relatively little, while companies and business consultants, worldwide, have contributed much. On the other hand, universities are ahead of practice in the social and behavioral sciences and in systems integration concepts.

Core Knowledge Versus Needed Research

The last observation about TQ's origins in the business world rather than in academic research should not give the impression that TQ must be legitimized and made rigorous by academic research before it can be assimilated into universities for teaching and further research. TQ does represent a coherent structure that commands widespread assent and that has been tried and found useful in pioneering companies, though there are few large scale statistical studies of TQ success. The challenges to academic research are:

- To provide a firmer foundation for the difficult task of implementing TQ in practice, which is clearly the most urgent applied challenge; this has little to do with improved techniques and much to do with management and organizational processes.
- To seek out possible weak points in the TQ structure and shore them up or replace them when they are found wanting, not to start from scratch and build up something new.
- To clarify obscurities and inconsistencies in the TQ structure whenever they are discovered.

- To unify diverse TQ ideas and practices into a parsimonious and coherent theoretical structure without sacrificing content to empty mathematical rigor.

In pursuing these challenges, academicians should keep in mind that organizations who implement TQ ideas often evaluate the success of tryouts of new methods by careful before/after performance comparisons; for example, they may estimate cost savings accruing from a particular quality improvement intervention. They have not typically used the empirical methods — especially regression analyses of large data bases — commonly employed or advocated in some areas of academic research. Simple before/after comparisons cannot be dismissed because other things are changing at the time quality interventions are made. *Intervention analysis* (Box and Tiao) can make these comparisons rigorous by modern time-series analysis. Thus every quality improvement project carried out in an organization offers solid information about the effectiveness of TQ methods, information that needs to be pooled and consolidated within and between organizations. (See also the discussion of business research issues in Section 7.)

6. What is New About Total Quality?

For many, the ideas and precepts of TQ seem intuitively appealing, so much so that managers sometimes assume that they have been applying them all along and business school professors assume that they have been teaching them all along. These assumptions rarely stand up under close examination, which usually reveals that some precepts have been followed or taught but that many others have been violated. (We do not believe that TQ ideas and precepts are always correct or always applicable; that is a separate issue for research. We do believe that TQ differs in important ways from what people have always done, thought, and taught.)

Our belief that TQ is different can be best appreciated by close observation of outstanding organizations — in Japan, the United States, and elsewhere — which have successfully implemented their own approaches to TQ. The contrast between these companies and ordinary companies cannot easily be conveyed in words. Photographs of TQ factories versus traditional factories help a little: TQ factories tend to be clean, roomy, and uncluttered with in-process inventories.

We can, however, set forth TQ precepts that collide with principles of management that have been, and often still are, widely taught in business schools and accepted in business practice. To show the extent of the differences, we have assembled 38 instances below. The list could no doubt be extended.

38 Points of Divergence Between TQ and "Traditional Good Management"

- Under many circumstances, choosing suppliers by competitive bidding based on lowest price has been discredited.
- It is no longer assumed that higher quality is attainable only at higher cost. When higher quality is attained by reduction of waste (or elimination of constraints), lower cost is a consequence of higher quality.
- Quality improvement and assurance are not tasks for professional specialists alone; they concern everyone in an organization.
- Final inspection as a means of achieving quality has been deemphasized, though not eliminated; the shift is to prevention of defects upstream in the process. (Improvement of quality by weeding out defects on final inspection does increase cost.)
- The ideas of "acceptable quality level" (AQL) and "average outgoing quality limit" (AOQL) can impede good business practice because they discourage continual improvement of quality. (Generally, any attempt to set minimum standards — however advanced they may initially seem — discourages improvement once the minimum standards have been met.)
- Really high levels of quality cannot be achieved by sampling inspection, regardless of cost.
- Management must influence or control upstream causes in processes in order to influence quality, costs, or profits, which are only the downstream results of processes.
- TQ has led to major changes in ideas about cost accounting. (An influential book by Johnson and Kaplan is called, *Relevance Lost: The Rise and Fall of Management Accounting*; a useful sequel by Johnson is called *Relevance Regained: From Top-Down Control to Bottom-Up Empowerment*.)
- The feasible span of managerial control can greatly exceed the rules of thumb that have been offered in management textbooks; indeed, the term" leaderless team" has been given operational meaning.

- Tradeoffs are not inevitable. If you think that the only choice is between alternatives A and B, you may find with a little thought, brainstorming, and investigation that another alternative, say Y, dominates A and B.
- One fundamental difference between TQ and traditional good management is that the latter has stressed optimization within given constraints, while TQ gives high priority to removal or relaxation of constraints.
- In aggregate, simple statistical tools, used widely, offer more potential for improvement than do sophisticated tools used only by a few specialists.(Both simple and sophisticated tools, of course, are potentially valuable.)
- Education and training conducted without opportunity for immediate application depreciates very rapidly. "Just-In-Time" training is often the goal for quality improvement projects.
- Increasing employment may be a bad response to a request to expand output; better use of current employees through process improvement should be the first thought.
- Decreasing employment is often a bad response to a request to reduce costs; better use of current employees through process improvement should be the first thought.
- It is sometimes easier to make big improvements than small ones.
- Some findings of behavioral scientists — for example, that problem-solving teams have important advantages over individuals — have relevance to business.
- Reduction of cycle time for all processes is a high priority goal not only because speed is intrinsically desirable — say, from the standpoint of inventory costs and marketing capabilities — but because there are usually desirable side effects — for example, improved quality.
- Inventories are at best necessary evils, and constant pressure to reduce them is called for. Zero inventories are the target. Reducing inventories often reveal opportunities for process improvement.
- Employees should not be urged to appear busy if they have no value-adding work to do.

- Fast prototyping is a valuable strategy for new product and process development, both for manufacturing and services.
- Creativity in working around problems and backup for emergencies can impede long-term improvement. Good expeditors are not necessarily good managers.
- If it's not broken, it's a good time to think about developing a better preventive maintenance program.
- It is possible to bring about radical changes in organizational culture, as is illustrated by Japanese-style suggestion programs in which employees average one or more improvement suggestions per week, with most suggestions promptly implemented.
- It is not necessarily desirable, and may even be counter-productive, to aim for high machine utilization. However, high employee utilization is desirable, though not at the cost of producing unneeded output.
- Aside from considerations of seasonal demand by customers, producing more than the market can quickly absorb leads to serious waste.
- In many circumstances, aiming at long production runs and large batch size is not a wise strategy. It may be better to acquire the ability to change production setups quickly so that several product variations can be produced every day or week, thus more closely matching production and market demand.
- Persuading customers to buy something they don't really want can be a counter-productive approach to marketing. The product or service should be improved to supply what customers do in fact want.
- Special promotions, discounts, deals, and sales contests are a dubious marketing tool.
- Automation and computerization are no guarantee of improved quality or lower costs; they are justified only when they can reduce variation or cut cycle time economically.
- Exhortation to do better or to try harder seldom leads to substantial and sustained improvement; specific changes in work practices and processes must be made.
- Tools and techniques for quality improvement — including use of statistics, teams, and small groups — are useful only if the organizational

culture is sound, including especially the orientation towards pleasing customers.

- Middle managers and staff specialists need to emphasize training, coaching, and facilitation rather than simply giving or passing on orders.
- Traditional ideas about systems of merit ratings, incentives, and compensation of employees have come under critical scrutiny, and the case for them has become more and more uneasy.
- Good managers must understand the specific processes of an organization; the idea of that management skills are readily transferable to any kind of organization is misleading.
- In managing processes, it is essential to understand the nature of statistical variation and to try to isolate the root causes of variation.
- It is important to avoid tampering with processes that are in a state of statistical control but to search for assignable causes when the processes go out of control.
- The Total Quality approach to reliability is to improve reliability during product development, rather than to predict field reliability. (For further discussion, see the subsection, "Applications of TQ in Engineering", in Section 8.

In commenting on the above listing of differences between TQ and traditional good management, Willard Zangwill suggested a broader perspective: TQ entails a fundamental shift from managing through hierarchy and budgets to managing through monitoring of processes. The focus on process leads to three empirical observations:

- Waste is much more widespread than was formerly believed.
- Near-zero defects and near-zero cycle times are achievable for many processes.
- Sustained improvement, sometimes very rapid, can be achieved.

These three observations, in turn, lead to many of the propositions and observations in the list of 38 points of divergence.

We can also set forth major behavioral differences that distinguish TQ from traditional good management:

Salient Behavioral Differences (Johnson)

Traditional:	Total Quality:
Accept constraints as given	Remove constraints continuously
Follow finance-driven rules	Create environment for learning
Manipulate output to control costs	Provide output as needed, on time
Persuade and sell	Build customer loyalty
Build for scale and size	Build for flexibility
Increase speed within parts of system	Decrease lead time of entire system
Specialize and decouple processes	Link specialized parts into teams
Utilize resources fully	Keep idle resources ready.

7. Actual and Potential Impact of TQ on Academic Areas in Business Schools (Schonberger)

- *Corporate finance:* Financial numbers fail to show the real strength of a firm because they do not clearly reflect information about quality, product design, time-to-market, customer loyalty, etc. Yesterday's "buy" list is too often tomorrow's basket cases. There is plenty of room for research and teaching about possible ways to capture a more complete picture of company strength.
- *Financial accounting:* Same reasoning as with corporate finance except that the research/teaching emphasis shifts from external assessment to internal reporting, for example, on innovative changes in company P&L statements and needs for changes in generally accepted accounting principles. Motorola's work in this area — for example, emphasizing speed in the closing of the books — may be suggestive.
- *Management accounting:* Management accounting/cost accounting is already in the throes of sharp shifts in the direction of research/instruction/service:
  - ➢ Activity based costing (ABC). These innovations arose partly because just-in-time quickness left traditional job-order costing "in the dust"; today ABC is also being promoted as a way to drive continuous improvement — by showing where the most costly wastes are. [Johnson (supported by Schonberger) disagrees with the

latter: "the use of ABC is itself a waste and tends to reinforce the old paradigm, not TQ".]

- ➢ Performance measurement/management: data in traditional periodic financial statements poorly serve the organization whose main emphasis is on quality, quick response/time-based competitiveness, flexibility, teamwork, external partnerships, design simplicity, etc. Considerable research, in partnership with industry, is under way in these areas.

Johnson extends this as follows:

- ➢ The key problem with accounting in the age of Total Quality is its inability to project either the voice of the customer or the voice of the process. Traditional management accounting practice has top management throwing accounting numbers over the wall to operations people and expecting them to manipulate processes in whatever way it takes to achieve accounting targets. In the Total Quality company, by contrast, the practice should be for operations people to throw nonaccounting data over the wall to top managers and insist that they reconcile operational data with accounting results. The Total Quality company will not ask operations people to cover "unabsorbed overhead variances" in monthly cost reports by manipulating processes; instead it will ask top management to cover such variances either by creating new revenue streams or redeploying (not laying off) "excess" resources.
- ➢ Total Quality changes the basis of the business school research and teaching paradigm from the neoclassical economic theory of the firm-as-production function, and from the theory of human behavior that stresses maximization of self-interest, to a theory that focuses on systems, values, and group learning. This new mindset will clear the way to giving a major place in the curriculum to Clausing's "in-depth Total Quality" or "Second Generation Total Quality".

- *Human resource management:* TQ has already triggered an outpouring of articles and books on pay-for-skills, elevated training of all employees, multi-skilling, cross-careering, elimination of job classifications (or even of the job classification system itself), hiring of team/innovation-oriented people, and fixing the broken suggestion system.

- *Organizational behavior (OB):* Research is just beginning into how TQ might affect organizational behavior. First flurries seem mainly to be putting TQ labels on established concepts, such as team building, reinforcement, socio-technical systems, open systems, hierarchy of needs, etc. Substantive new research concepts are the next step: for example, shift from private to public reinforcement and recognition, team building following organization of people into focused work-flow clusters, effects of continuous improvement on employee satisfaction, and work-life security versus job security.
- *Information systems (IS):* TQ effects on information systems are internal and external to the firm:
  - ➢ *Internal*: Field based studies reveal sharp reductions in numbers and kinds of computer transactions, and dismantling of some of the computer transaction based controls that firms had installed a generation ago. These changes stem from (a) controlling processes, which reduces exception/variation transactions (for example, on scrap, delays, stoppages), and (b) the waste elimination aspects of TQ cause re-examination of the need for certain subroutines, such as labor reporting.
  - ➢ *External*: At the same time, field studies show firm-to-firm information systems linkages of final customers (for example, retailers) with several echelons of the supply chain. Quality certification at the source, quick response, and waste elimination are the driving forces for these expanded information system treatments.
- *Marketing/sales:* TQ offers opportunities for marketers to promote company quality, responsiveness, continuous improvement rather than to cover up deficiencies in these areas, to organize design teams that include customers, to engage in benchmarking, and to devise pay and reward systems to emphasize customer retention. These topics are beginning to appear in marketing books and offer opportunities for research.
- *Economics:* Traditionally, economists have not considered management to be an important economic force. However, PIMS and GAO studies have shown significant value of quality; such micro-economic research studies no doubt will continue. Perhaps evidence will also be forthcoming on how quality and TQ elevate the performance of whole

nations. Economists have already taken note of how just-in-time systems are reducing the impact of inventories on economic cycles.

- *Engineering management:* New TQ related research areas include formation of extended product and process design partnerships, a goal of zero engineering changes after hand-off to production, and quick design-to-market.
- *Production/operations management:* TQ and Just-In-Time are already entering the research mainstream and are reflected in the most recent textbooks. Research and instruction is not yet well integrated with other functional areas and tends not to be very human-/team-/customer-centered.
- *Management science:* There seems to be little current awareness of a possible TQ oriented research thrust toward models and algorithms based on continuous improvement and away from optimization and tradeoffs. Instead, the current effect of TQ tends to be refinement of present simulation models (for example, simulations of different numbers of kanbans) and optimization models (for example, elaborating the economic order quantity model to allow for the negative effects of large lots on throughput time, scrap, and rework).
- *Mathematics/statistics:* The statistical process control side of TQ is potentially the home-ground of researcher/teachers in this area, but the main shift so far has been interest of specialists in refinements of control charts. Design of experiments and Taguchi methods have received intense study by specialists, but there has been little reflection of these ideas in the curriculum.

8. Actual and Potential Impact of TQ on Academic Areas in Engineering Schools (Clausing)

It is important to distinguish between basic TQ and functionally specific, in-depth TQ. Basic TQ includes Deming's 14 points, PDCA (Plan-Do-Check-Act), seven QC (Quality Control) tools, seven management tools, good quality, problem prevention, employee involvement, policy (strategy) deployment, continuous improvement, focus on customers, total participation, and management by facts. Eight years ago the director of copier development and production for Fuji Xerox said that for product development there are two

elements of (in-depth) TQ: QFD (Quality Function Deployment) and Robust Design (Taguchi). That is still true.

QFD and Robust Design provide more in-depth, sophisticated, and powerful approaches than those embraced by basic TQ. QFD focuses all activities on the voice of the customer via systematic, disciplined step-by-step deployment. Robust Quality emphases perfect quality, the ideal customer-satisfaction performance value(s), not settling for lesser levels of "acceptable" quality as defined by specification limits. Robust Quality also provides efficient continuous improvement via better measures of quality, designed experiments, and stress testing to achieve robust systems (product, production, and others). Problem prevention is emphasized by optimizing robustness very early, usually in technology development, not waiting for problems to actually occur.

A big problem in the United States is that companies implement only basic TQ, and then find that they are still not fully competitive with the best Japanese companies. The in-depth part is needed to be competitive, but American companies tend to regard it as too hard. As David Kearns has pointed out, the Japanese have higher expectations.

Applications of TQ in Engineering

The primary applications of TQ in engineering are Concurrent Engineering and JIT/SPC production. Concurrent Engineering in turn can be thought of as Basic Concurrent Engineering, QFD (expanded into Enhanced QFD), and Robust Design (Taguchi). Basic Concurrent Engineering can be viewed as basic TQ applied to product development; improved process and teamwork.

TQ also plays a role in durability and testing, and engineers are increasingly involved in consumer research.

Reliability occupies an interesting position. The traditional approach is to attempt to predict field reliability during product development. The TQ approach is to improve reliability during product development, especially early. The two approaches are incompatible. Prediction requires that the design be kept constant (thus not improved) while large numbers of trials are run to narrow the confidence range. Improvement requires that the design be evaluated in many configurations (typically by designed experiments) with only enough trials for each configuration to obtain a reasonable estimate of the improvement vector. The improvement approach also emphasizes stress testing, that is, challenging each design point with a fairly nasty set of customer use conditions,

so that information is quickly acquired. This contrasts with simply running successful trials from which little is learned. The psychological difference between the two approaches is huge. People are often confused by the fact that a metric that is very good for some purposes (quantifying field reliability) is poor for a related purpose (early improvement of reliability).

In considering the relation of TQ to engineering schools, much is to be said for joint business/engineering training rather than a "TQ for Engineering" approach. One example is the Leaders for Manufacturing (LFM) program, a joint two-year program of the School of Engineering and the School of Management at MIT, which leads to two MS degrees, one from each school. The students, all of whom have BS engineering degrees, take an intense load of management courses during their first summer, including a TQ course taught by Professor Shiba. About 60 percent of the students take a course on Improved Total Development Process (Concurrent Engineering). A course like this and a good production management course seem like the best manifestations of TQ in engineering schools.

9. Skeptics

The recent Procter & Gamble University Challenge for Tuskegee University and the University of Wisconsin-Madison revealed that there were constructive skeptics among the faculty members and administrators who attended. Among the questions and reservations expressed were the following:

- TQ sounds like a fad; TQ advocates make unrealistic claims.
- Although there are precedents (e.g., OR and OB) the use of an acronym like TQ for an intellectual concept is distasteful.
- There is doubt as to whether TQ represents anything new.
- In many attempts at implementation of TQ, complete frustration and disappointment, or at most limited success, is the initial result. Many employees do not buy in. (Often these attempts are based on a shallow or narrow understanding of TQ, but even well executed attempts encounter obstacles and frustrations.)
- TQ seems to be a collection of disparate elements, not a unified body of knowledge.
- There is, as yet, little solid academic research relating to TQ.
- There does not seem to be convincing evidence that TQ works, and some quality leaders have encountered financial problems.

- There are reservations about the Baldrige National Quality Award as a measurement of organizational excellence, especially about its alleged emphasis on processes rather than results.
- TQ may be fine for business schools, but the potential for engineering is less clear except, perhaps, for Industrial Engineering and Chemical Engineering, which focus on process improvement. Elsewhere, product quality and improvement may be best sought through robotization.
- TQ puts too much emphasis on management of processes and leads to neglect of bottom line results.
- TQ is "management by stress", just another management ploy to increase productivity.
- TQ promises long run improvements but cannot aid in crisis situations, say when radical down sizing is needed or bankruptcy looms.

Some (not all) of these points have an element of truth, but the overall thrust, in our judgment, is wrong. It is true that TQ can be treated as a fad or program of the year. Implementation of TQ is easy to bungle. Even successful implementation of TQ for ongoing processes is no guarantee of wisdom in all areas of management, such as acquisitions.

Against this, the positive experiences with TQ implementation by the sponsors of the Total Quality Forum and the experiences of American transplants of leading Japanese companies like Honda and Toyota are persuasive. What we find here is a total change in thinking, not a new collection of tools.

If the *name* "TQ" were to disappear, one would still have to look to its underlying ideas for guidance in making practical improvements in business management.

There are, however, genuine dangers:

- Some experts in particular disciplines are trying to rewrite TQ around their own unique discipline: for example, accounting, engineering, human resources, or statistics.
- There are attempts to put forth a one-best-model of TQ, in spite of the fact that most successful companies have "home grown models" that blend TQ constituents from many sources to fit their own requirements.
- The need is not to teach the "one way" but to base teaching on the purpose of processes and systems and how they function. The knowledge and skills needed will change and improve over time, allowing for continuous improvement of the TQ system itself.

- Single constituent approaches, such as "statistical process control" or "teams", don't seem to work well over time.
- Slavish imitation of TQ efforts made by one successful organization may not lead to a good result in a different organization.
- It is easy to focus on tools and techniques, but very hard to understand and achieve the changes in human attitudes and behavior that are entailed in TQ.

10. Issues in Implementation of TQ

TQ is not a distilled body of knowledge, as the term "core body of knowledge" might suggest; it includes also implications and prescriptions for action in management of real organizations. Fully to describe TQ, therefore, we must say something about the problems that arise when organizations attempt to implement TQ. There are some stunning successes, but there are also disappointments, even outright failures.

Disappointing results, when they occur, may reflect weaknesses of the TQ ideas themselves. However, implementation of TQ is often attempted without a full grasp of the nature of TQ. Casual observation suggests that certain mistakes are made repeatedly. O'Dell has singled out some of the pervasive mistakes:

Why TQ May Not Work (O'Dell)

1. Still a "program"
   - despite the rhetoric otherwise
2. No short-term results
   - The idea that measurable benefits lie *only* in the distant future
   - No attempt to get short-term successes
3. Not driven by:
   - Customer focus
   - Business issues
   - Senior management
4. Structural items block change:
   - Compensation system
   - Promotion system
   - Accounting system
   - Policies and Procedures
   - Specialization/functionalization
   - Status symbols: offices, perqs.

5. Goals set too low
   - "Last year + inflation + 5%"
   - Not stretch goals
   - No outside benchmarks
6. Not benchmarking or doing it poorly
   - No training in Benchmarking/MKG
   - Not linked to strategy
   - Benchmarking only competitors
   - Only competitive analysis
   - Playing catch up
7. Still "Command and Control"
   - Hierarchical/bureaucratic/status
   - Fear driven/game-playing culture
   - Cost reduction/budget/schedule
   - Senior management key players
8. Training
   - Too little and mainly senior managers
   - Wrong kind (only classroom)
   - Tools focus (not problems)
9. Staff — not line — driven
10. Mainly product focus not process focus.
11. Little real empowerment
    - Words, but not deeds
    - Lack of training/delegation
    - Technical, not social, change
12. Too successful/complacent
    - Not change/learning receptive
    - Not invented here/Arrogance/No. 1
13. Not a learning organization
    - Not change/learning receptive
    - Low flexibility/creativity
14. Failure to address three questions
    - Is this another program?
    - What's in it for me?
    - How can I do this on top of everything else?

15. Senior management not personally and visibly committed, and actively participating

The following listing was stimulated by O'Dell's listing above. Although there is some overlap between the two lists, it is interesting to see that the second list taps additional problems that can arise in implementation, thus bringing out more fully how hard it is to implement TQ in practice.

Why TQ May Falter: Further Possibilities

1. Emphasis on quality improvement teams for cross-functional problems to the neglect of individual efforts at local improvements.
2. Rigid team problem-solving sequences that do not stress understanding and mapping of processes, narrowing the focus to specific and realistic goals, nor trying out of promising improvements without long, preliminary investigation.
3. Belief that a process must be in a strict state of statistical control before it can be improved.
4. Belief that more data are always desirable, regardless of relevance.
5. Failure to use well-established marketing research survey techniques in assessing customer satisfaction.
6. Belief that shortages of personnel and funds make meaningful quality improvement impossible.
7. Failure to recognize that quality improvement is a personal responsibility at all levels of an organization.
8. Inability even to contemplate the possibility that removal or modification of existing constraints is possible. Substantial change in traditional ways of doing things seems unthinkable.
    - "Doctoral training has always taken many years; we can't shorten it without giving up something essential."
    - "All decisions involve tradeoffs: if we want more of one thing, we must give up something else."
    - "Adversarial union relations make Total Quality impracticable here."
    - "Governmental regulations tie our hands."
    - "Our department is not doing a very good job, but the company can't be good in all departments." (Statement actually made in a university.)
9. Belief that "we are different/unique".
    - What works in businesses won't work in universities/governments/etc.

- What's possible in Japan won't work in the United States
- Etc.

10. Failure to realize that Total Quality demands a transformation of organizational culture as well as specific quality improvements.
11. Failure to try to remedy educational deficiencies (K-12) of our workforce. Employees who can't read and do simple arithmetic can't handle control charts.
12. Blind faith in automation/computerization.
13. Failure to make specific improvements irreversible; as a result of this failure, gains are not retained.
14. Failure to extend solutions to one problem to similar problems elsewhere in the organization.
15. Failure to see the organization as a collection of interrelated processes making up an overall system; both the individual processes and the overall system need to be identified and understood.
16. Senior management — and others — feel that there is little or no time available for TQ implementation.
    - Tendency to treat each outcome as a special cause demanding personal attention and, often, intervention.
    - Flawed systems keep everyone pinned down in fire fighting.
    - Rework demands a big share of everyone's time.
    - Extensive waste in all work processes.
17. Individual managers may be afraid of failure and hence resist trying to improve, even when the feasibility of improvement has been demonstrated elsewhere.
18. Failure to appreciate the concept of global thinking by all employees, the role of competition, strategic vision, world-wide sourcing, and others.

Need for Further Evolution of TQ

The pervasiveness of these implementation problems is in part a reflection of the still immature development of TQ. One excellent blueprint for further development is the book by Peter Senge, *The Fifth Discipline*, cited in Section 2. Senge's book deals with issues of which many people are unaware, and that are often not stressed even in the TQ literature, but that are vital to the success even of what we called "First Generation TQ" or "Basic TQ".

For example, there is a need at all levels of organizations for people to be open to changing their minds when challenged by discordant evidence. Continuous improvement inevitably means that some of the things we have done or some of the beliefs we have acted upon can be improved; it does not mean that they were "wrong". It is very hard for all of us to get over the feeling that the adoption of change means that we had been wrong in the past, and to accept improvement as gratifying achievement rather than acknowledgment of past failure.

Appendix A
Selected Background Readings on TQ

Here we list a few book-length overviews of TQ for readers who are new to the ideas of TQ and who want more extensive background. These are books that have been found helpful by members of the Working Council; they in no sense provide a bibliography of TQ. No specialized works are included.

Also included on this list are shorter but self-contained treatments of certain major components of TQ.

- Berwick, Donald M., A. Blanton Godfrey, and Jane Roessner (1990), *Curing Health Care: New Strategies for Quality Improvement*, Jossey-Bass, San Francisco.
- Deming, W. Edwards (1986), *Out of the Crisis*, MIT Center for Advanced Engineering Study, Cambridge, Mass.
- Cole, Robert (1989), *Strategies for Learning*, University of California Press, Berkeley, California.
- Dertouzos, Michael L., Richard K. Lester, and Robert M. Solow (1989), *Made in America: Regaining the Competitive Edge*, MIT Press, Cambridge, MA.
- Doyle, Robert (1992), *Gain Management*, AMACOM, New York, NY.
- Grayson, C. Jackson, Jr. and Carla O'Dell (1988), *American Business, a Two-Minute Warning: Ten changes managers must make to survive into the 21st Century*, The Free Press, New York.
- Hauser, John R. and Don Clausing (1988), "The House of Quality", *Harvard Business Review*, Vol. 66, No. 3, 63-73.
- Ishikawa, Kaoru (1990), *Introduction to Quality Control*, 3A Corporation, Tokyo, Japan. See also Ishikawa (1985), *What Is Total Quality Control: the Japanese Way*, Prentice-Hall, Englewood Cliffs, N.J.
- Imai, Masaaki (1986), Kaizen: *The Key to Japan's Competitive Success*, Random House, New York.
- Johnson, H. Thomas (1992), *Relevance Regained: From Top-Down Control to Bottom-Up Empowerment*, The Free Press, New York.
- Juran, Joseph M. (1989), *Juran on Leadership for Quality: An Executive Handbook*, New York: The Free Press.
- Juran, Joseph M. and Frank M. Gryna (1988), *Juran's Quality Control Handbook*, Fourth Edition, McGraw-Hill, New York.

- Lillrank, Paul and Noriaki Kano (1989), *Continuous Improvement: Quality Control Circles in Japanese Industry*, Center for Japanese Studies, The University of Michigan, Ann Arbor, Michigan
- Neave, Henry R. (1990), *The Deming Dimension*, SPC Press, Knoxville, TN.
- Osborn, Jack D., Linda Moran, Ed Musselwhite, and John H. Zenger (1990), *Self-Directed Work Teams*, Business One Irwin, Homewood, IL.
- Robinson, Alan, editor (1991), *Continuous Improvement in Operations: a Systematic Approach to Waste Reduction*, Productivity Press, Cambridge, Massachusetts.
- Schein, Edgar H. (1985), *Organizational Culture and Leadership*, Jossey-Bass, San Francisco, CA.
- Schonberger, Richard J. (1990), *Building a Chain of Customers: Linking Business Functions to Create the World Class Company*, The Free Press, New York, 1990. See also Schonberger, Richard J. (1986), *World Class Manufacturing*, Free Press, New York.
- Stahl, Michael J. and Gregory M. Bounds (1991), *Competing Globally through Customer Value: The Management of Strategic Suprasystems*, Quorum Books, New York.
- Taguchi, Genichi and Don Clausing (1990), "Robust Quality", *Harvard Business Review*, Vol. 68, No. 1, 65-75.
- Walton, Mary, *The Deming Management Method* (1986), Dodd, Mead & Company/Putnam, New York.

Employers' Needs Working Council

Working Council Membership

Co-Chairs

Thomas J. Murrin
Dean, A.J. Palumbo School of Business Administration, Duquesne University

Anne M. Mulcahy
Vice President, Corporate Human Resources, Xerox Corporation

Members

Linda R. Cooper
Vice President, First Chicago Bank

Paula D. Fleming
Manager, Education and Training, Xerox Corporation

Robert S. Kaplan
Professor, Harvard Business School

John E. Kelsch
Director, Quality, Xerox Corporation

Henry J. Lindborg
Executive Director, International Values Institute, Marian College

William B. Locander
Chairman, Marketing Department, University of South Florida

Curt W. Reimann
Director of Quality Programs, National Institute of Standards and Technology

Robert S. Sullivan
Dean, Graduate School of Industrial Administration, Carnegie Mellon University

Contents

Executive Briefing
Work Process
Findings and Conclusions
Recommendations
Appendix A Interview Guidelines
Appendix B Employers' Needs
Appendix C Key Values

Employers' Needs Working Council

Executive Briefing

Description of the Council's Charter

The charter of the Employers' Needs Working Council is to identify the requirements of industry as to the methodologies and principles of Total Quality Management (TQM) that should be incorporated into engineering, business and other curricula.

The Council will produce a short-term action plan and a longer-term vision in a publishable format. In addition, the Council will prepare summary findings for the Total Quality Forum 1992.

Methodology

1. Develop criteria and select organizations for surveying needs; consider follow-up interviews with selected organizations based on survey results
2. Determine whether TQ requirements are integrated into recruiting practices — school selection, pre-screening of applicants, communication of expectations, determination of appropriate match of interests, offers and results, and post-selection success
3. Summarize findings and develop recommendations
4. Review recommendations with Leadership Steering Committee
5. Prepare and deliver paper/presentation at Total Quality Forum 1992

Key Findings and Conclusions

Virtually all employers are looking for graduates with a strong customer orientation. Graduates are more employable, and companies are better served, when graduates understand the concepts of TQ, including how and when to use the basic tools. Experience in using TQ tools and solving problems as a member of a team is highly desirable, and some graduates in specialized fields should

have experience in applying advanced tools (e.g., design of experiments). However, few employers have linked their expectations about TQ knowledge and experience to their recruiting practices.

The Council grouped employers' needs and expectations of graduates into eight clusters of orientation and knowledge, which ideal recruits should possess. These clusters, which are not necessarily exclusive or independent of each other, are:

- Customer Orientation
- Practical Knowledge/Application of Quality Tools
- Fact-Based Decision Making
- Understanding of Work as a Process
- Team Orientation
- Commitment to Improvement
- Active Learner
- Systems Perspective

Key Recommendations

The Council developed recommendations for universities, the Leadership Steering Committee and employers:

- Universities should design a total learning experience using TQ principles to produce knowledgeable and experienced TQ graduates, including demonstrating quality in the university's work process and involving students in improvement projects.
- Universities should develop goals, criteria and assessment plans to measure how well they are meeting employers' needs and expectations.
- Universities should ensure that faculty human resource practices are aligned with TQ principles (e.g., reward and recognition systems and tenure policies that encourage teamwork and collaboration — as well as individual faculty contributions; faculty recruitment that reflects TQ principles).
- The Leadership Steering Committee should deploy information about employers' needs and expectations to small-and medium-sized companies.

- The Leadership Steering Committee should develop a process to enable employers to provide ongoing support to universities in understanding TQ.
- Employers must incorporate identified TQ needs and expectations into their recruiting practices.

Work Process

The Council members agreed on a work process to fulfill the charter; the steps are:

1. Develop criteria and select organizations for surveying needs. Consider follow-up interviews with selected organizations based on survey results.
2. Determine how recruiting is conducted — school selection, pre-screening of applicants, communication of expectations, determination of appropriate match of interests, offers and results, and post-selection success.
3. Summarize findings and develop recommendations.
4. Review recommendations with Leadership Steering Committee.
5. Prepare and deliver paper/presentation at Total Quality Forum in 1992.

A select number of private-and public-sector employers with established TQ reputations were identified for inclusion in the study. The Council also used materials and curriculum from companies participating in the 1992 University Challenge. Participating employers were:

- Air Force
- American Express Life Assurance Company
- American Express Travel Related Services
- Analog Devices
- State of Arkansas
- City of Austin, Texas
- Center for Quality Management
- Corning
- Council for Continuous Improvement
- Federal Express
- First Chicago Bank

- Henry Ford Health Care System
- City of Madison, Wisconsin
- Marriott Corporation
- Milliken
- Motorola
- National Center for Manufacturing Science
- Procter & Gamble
- Quality Share Group
- Solectron
- Westinghouse
- Xerox Corporation

The Council developed a set of interview guidelines to assist in collecting the data from employers; a copy is included in Appendix A. The format of the actual interviews varied from structured to somewhat free form, depending on the level and expertise of the interview subjects.

Findings and Conclusions

The data collected from employers about their needs and expectations of graduates with respect to TQM revealed a clear pattern of eight clusters of orientation and knowledge, which ideal recruits should possess:

- Customer Orientation
- Practical Knowledge and Application of TQ Tools
- Fact-Based Decision Making
- Understanding of Work as a Process
- Team Orientation
- Commitment to Improvement
- Active Learner
- Systems Perspective

Definitions of these clusters are given in Table 1.

Table 1. The Ideal Recruit's TQ Orientation and Knowledge

Cluster	Definition
Customer orientation	Customers — their needs and our solutions to their problems — are why organizations exist; all employees must continually strive to improve customer satisfaction
Practical knowledge and application of TQ tools	Hands-on skill in using Total Quality processes and tools, within a business context
Fact-based decision making	The need for the right data at the right time for the right action; asking "What do I need to know?" and "How will I act on that information?"
Understanding of work as a process	Work is a process organized around outcomes; as a process, work can be improved and refined — even radically overhauled — to achieve improvement
Team orientation	Ability to work effectively with others; minimize unproductive conflict while encouraging diverse opinions and constructive debate; valuing the greater good of the company above personal, unit or functional goals
Commitment to improvement	Continuously striving for improvement, from the small and incremental to the big breakthroughs
Active learner	Learning is central to success; ability to gain insight by reflecting on successes and failures; to learn from co-workers, competitors and customers
Systems perspective	Ability to see "the big picture," across hierarchical, organizational and functional boundaries

Customer Orientation

Virtually all employers interviewed cited the need for graduates to have a strong customer orientation. This was particularly important for companies like Marriott and Federal Express, with tens of thousands of employees who have direct contact with customers. Marriott recruiters screen for high customer orientation as part of the hiring process. Federal Express has concluded that teaching customer orientation in a classroom has limited effectiveness; the Quality and Personnel staffs believe that people learn customer focus through hands-on experience in a customer-orientated setting.

Roy Stata, Chairman and CEO of Analog Devices, said that engineering students should learn to listen to the "voice of the customer" by discovering the latent needs of customers, making these needs operational, and redesigning products and services to satisfy these needs. The customer is not always right, but believing that the customer is probably right is the appropriate base-line assumption.

TQ Tools and Fact-based Decision Making

Graduates are more employable, and companies are better served, when graduates understand the concepts of TQ, including when and how to use the tools. The seven statistical tools (for quantitative data) are:

- Checksheets
- Pareto diagrams
- Histograms
- Scatter diagrams
- Graphs
- Cause-and-effect diagrams
- Control Charts

The new seven (management) tools (for non-numeric data) are:

- Relations diagram
- Affinity diagram
- Tree diagram
- Matrix diagram
- Matrix data-analysis diagram
- Process decision program chart
- Arrow (activity network) diagram

Some graduates with specialized or advanced knowledge in TQ should have experience with advanced techniques such as design of experiments, benchmarking, Quality Function Deployment and Hoshin Kanri Planning.

Along with the tools, students should learn a systematic process for solving problems and making decisions based on facts, rather than opinions. The following seven-step method is an elaboration of the Plan-Do-Check-Act (PDCA) cycle:

1. Identify and select the theme
2. Collect data
3. Analyze data
4. Identify and select solution
5. Implement the solution
6. Check whether the solution worked
7. Standardize the solution; reflect and identify the next theme.

Professor Shoji Shiba, an expert formerly associated with the Japanese Union of Scientists and Engineers (JUSE) who advises Analog Devices and the Center for Quality Management, emphasizes that TQM is more skills and practices than specific techniques. He suggests a partnership between universities and industry to teach students the relevant skills and practices. Citing that Japan's progress in TQM has been greatly aided by a monolithic understanding of TQ principles, it would be beneficial if U.S. academics could develop, through textbooks and courses, a common language of quality and a standard set of fundamental TQ principles.

Gail Warden, President and CEO of Henry Ford Health Care System, talked about the need to aggressively include quality principles and tools in the graduate school programs related to business, health and administration. Several employers expressed and interest in pushing quality tools down to the community college level, enabling them to hire entry-level line employees with basic skills in place.

To ensure that the latest learning gets shared and keeps the academic world up to date, Ellen R. Williams, Senior Vice President of American Express Travel Related Services, stressed the need for partnerships between business and education and internships that bring students into the work environment.

Work as a Process and Commitment to Improvement

Success in TQM requires more than teaching tools and concepts in the classroom. Art Schneiderman, Vice President of Quality at Analog Devices, admits that TQM is not intellectually "heavy." The seven TQ tools are quite simple and can be learned by people who have had only a sixth-grade education. The TQM concepts of customer focus, empowering people in the organization, and the need for continuous improvement are quite natural to people in Western cultures. To be successful, TQM requires intense focus on process. Schneiderman used the following equation:

GOOD RESULTS = GOOD PROCESS + SKILL WITH TOOLS

The "Good Process" is the difficult part of the equation. Western and academic thinking have fostered the belief that skill with tools brings good results, but this is not correct with TQM. Organizations will not achieve lasting results without good processes. Well documented processes also form the foundation for cycle time reduction.

Jerry Fishman, President of Analog Devices, agrees that the key issue is for students to view what they do as processes. Then they can define the process, test the process, work the process, and make it better each year. He pointed out that even simple tasks are processes that can be studied and improved. Academic institutions need to educate students about processes, especially processes that create things and improve things.

Today's universities operate by giving students problems to solve. For the future, Schneiderman says that schools should learn how to teach students how to identify problems that are worth working on (i.e., problems for which solutions are likely to be found). Complex managerial and organizational problems require a heavy reliance on the "in" words — intuition, invention, inspiration — which have been ignored in favor of analytic skills. He also recommended that engineering schools revert back to teaching the scientific method: moving from hypotheses to data, back to hypotheses, returning to data, and so on.

John Yasinsky, President of Westinghouse Power Systems, believes that every engineering and business school graduate should have a basic working knowledge of the key elements of TQ and their relationship to continuous improvement of business performance.

Team Orientation

After customer orientation, team orientation was the most frequently cited trait. To Ray Stata, solving problems through teams is fundamental. Dennis Buss, Vice President of Technology, pointed out that projects today are so complex that one person cannot do it all. Today's advances require the integration of diverse technologies to achieve technical goals; hundreds of complex technical problems need to be solved, so incremental solutions by teams of engineers are required. Major cultural barriers — the not-invented-here syndrome or the feeling that building on other people's ideas is unethical — must be overcome.

Stata believes that engineering students need to learn how they can develop their contributions as part of a team, then deliver them through organizational structures. From his viewpoint, it would be desirable to have engineers work with students from other disciplines to solve complex problems and learn from them. The professor serves as facilitator for this mutual learning process, reinforcing that structure and culture are vital for the sharing of ideas and learning. At Westinghouse Power Systems, John Yasinsky suggested interdisciplinary project courses, with teams of engineering and business students addressing quality issues of importance to industry, and perhaps working directly with companies.

Since engineering students look to faculty as mentors and role models, Buss suggested that faculty members adopt a theme and select projects to help reach a common goal. This would allow students to see not only teamwork, but also incremental innovation — building on the work of others, on what existed before to meet new customer needs.

Active Learning

Employers are looking for students who are active learners, who can learn from a variety of "teachers" and experiences. The State of Arkansas, for example, is looking for graduates who can come up the TQ learning curve quickly once on the job, not a year or two after hiring.

Team-based projects (as described), case studies and simulations can provide a context for active learning. Case studies can present complex situations for which no correct answer exists. Multiple and conflicting points of view emerge from the discussion, but incomplete information and knowledge make easy,

definitive answers impossible. Simulations can help students understand the complex situations of dynamic, interrelated processes.

Real, hands-on experience is another approach. Sarah Nolan, CEO of American Express Life Assurance Company, cited a graduate of the University of Texas who had worked, as part of a team of students, on a semester-long project within a company. The company's assessment was the grade for the project. The student reported that working in the company provided him a very different picture from the one he received in class.

Students not only have to be taught how to learn, but also how to teach what they have learned. As part of the curriculum, students should be expected to lead classroom learning experiences.

Students also learn from their overall college experience. Nolan asked: "How can universities teach quality principles unless they embody them? If they do that, then they will know what to provide their students. They should start by understanding that the student is the customer of the University. Learning should be oriented in a team environment and integrated across functions... (universities) need to teach quality in context." Arizona State University was cited as a school that has adopted Quality principles; the administration has identified the students and Regents as their customers.

Systems Perspective

Traditional MBA programs deliver knowledge in functional specialties that mirror traditional organizations. But the future will likely require a horizontal, not vertical, view of the organization. Tom Lee, President of the Center for Quality Management, said that the major challenge for MBA programs is to introduce a total systems approach to managing organizations. The key management skill will be to manage processes that cut across traditional functional skills, by promoting interactions among people.

At Analog Devices, Schneiderman looks for students who will be good in managing cross-functional processes, who can operate in an ambiguous environment where both functional skills (what is traditionally taught and practiced) and cross-functional skills (how skills can be applied to create and improve a process) are required.

The findings for each employer are summarized in Table B-1 in Appendix B. The table also includes relevant information about the employer's TQM approach, recruiting and training.

The basic skills, attitudes and experiences that employers would appreciate having in college graduates were confirmed by the content of the Total Quality Management University Challenge courses conducted earlier this year. Universities and companies participating in the Total Quality Management University Challenge are:

Carnegie Mellon University	Xerox
Purdue University	Motorola
Georgia Institute of Technology and North Carolina State University	Milliken
University of Wisconsin (Madison) and Tuskegee University	Procter & Gamble
Massachusetts Institute of Technology and Rochester Institute of Technology	IBM

Specific findings from the curricula review are included in Table B-2.

Skill Categorization

The specific needs and expectations were categorized into five categories:

- Attitude/Awareness
- Instrumental Skills
- Interpersonal Skills
- Imaginal Skills
- Systems Skills

The following information on TQ skills is adapted from *Developing Human Values*, by Brian P. Hall, Bruce Taylor, Janet Kalven and Larry S. Rosen, a publication of the International Values Institute of Marian College.

Instrumental Skills

Instrumental skills are task-oriented. They encompass all the abilities that enable one to get a job done: that blend of intellectual and physical competencies that enable one to shape both ideas and the external environment. Within general education, instrumental skills are developed in reading, writing, logic mathematics, speech, application of tools such as the computer, etc. Instrumental TQ skills include the ability to:

- understand and apply the seven basic statistical tools
- collect data on customer satisfaction and cogently summarize findings

Interpersonal Skills

Interpersonal skills equip persons to develop and widen satisfying human relationships. Within a TQ environment, they include objective perceptions of self and others to foster trust and team work. Interpersonal TQ skills include the ability to:

- give and receive feedback non-defensively
- appropriately express disagreement on issues
- cope with conflict productively
- describe another's behavior non-judgmentally
- invite views of all group members

Imaginal Skills

Imaginal skills enable one to see alternatives, to change conventional ways of doing things, to remedy deficiencies, to grasp and make sense out of increasing amounts of data, to choose and act on complex alternatives. For TQ, aspects of root-cause analysis and solution development call upon imaginal skills. Imaginal TQ skills include the ability to:

- tolerate ambiguity
- play with a problem, redefining it from a fresh angle
- see connections between seemingly unrelated elements
- put existing data together in new ways
- use brainstorming techniques

In actuality a fertile imagination is an indispensable element in the acquisition and exercise of instrumental and interpersonal skills. It takes imagination to design tools or to relate creatively to other persons.

System Skills

System skills are that peculiar blend of competence, imagination, and sensitivity which gives rise to the capacity to see all the parts of a system as they are related to the whole. It is also the ability to plan and design change in a system (institutions, societies and bodies of knowledge) so as to maximally enhance the growth of the individual parts. It requires the integration of all the other skills. System TQ skills include the ability to:

- view work as a process
- in a small group setting, differentiate between interpersonal and system needs

- synthesize data from a variety of sources, i.e., personal experience, interviews, statistics, research reports, emotional input
- engage in long-term planning and goal setting, e.g., policy deployment
- generate a holistic view of the organization through cross-functional teams.

The eight clusters of employers' needs listed in Table 1 can be thought of as global characteristics. As such, they are somewhat general and would be difficult to implement directly. For example, simply telling a student that a strong customer focus is important for successful employment is not sufficient to instill an attitude of customer orientation. Rather, the student reaches such an awareness and develops the appropriate attitude as a result of a number of diverse experiences. These experiences could include participating in case studies and simulations that demonstrate the importance of customer satisfaction. Experiencing customer satisfaction from the customer's point of view contributes directly to developing the desired attitude. Universities that apply Quality to their own work processes treat their students as customers, and continuously work to improve the satisfaction of the student-customers.

A relationship matrix, one of the tools used in Quality Function Deployment (QFD), shows how each of the eight clusters might be achieved. The eight global characteristics become the WHAT list and are shown on the left side. The various means that can be taken to achieve them become the HOW list across the top. The relationships are shown by the symbols at the intersections of the WHATs and HOWs that are related:

- ■ Strong relationship
- ● Medium relationship
- ▲ Weak relationship

For example, simply teaching students the tools as part of the curriculum is not as strongly related to the employers' need as students' using the tools in a simulated situation (e.g., case study). Stronger still is applying the tools in a real situation (e.g., by involving students in the university's quality improvement efforts). The relationship matrix is shown in Table 2.

Table 2. Relationship Matrix

What \ How	A	B	C	D	E	F
Customer orientation			●	●	■	●
Knowledge, application of TQ Tools	●	●	■	●		
Fact-based decision making		●	■	■		
Understanding work as a process			●	■		●
Team orientation	▲	●	■	■	●	
Commitment to Improvement			●	●	●	■
Active Learner	▲	●	■			
Systems Perspective	▲		●			●

■ strong relationship
● medium relationship
▲ weak relationship

A Professors teaching TQ to students
B Students using TQ tools in case study or simulation
C Students using TQ tools on real issues
D Students using problem solving and Quality Improvement processes
E University treating students as customers
F University applying TQM to its work processes

Findings About Employers' Recruitment

Although employers are clear about their expectations of graduates' TQ skills, only a few have linked these to their selection and recruitment practices. Corning appears to be a leader in this area; the company completed a pilot in early 1992 for incorporating TQ requirements. Staff members have also developed a training program to increase hiring managers' skill in conducting assessments; the program has become part of the skill development process for managers. The Air Force has developed an extensive matrix of TQ skills required for promotion. American Express Life Assurance Company is in the

process of developing a new recruiting model, while American Express Travel Related Services recruits from colleges known for good TQ programs. The Council for Continuous Improvement asks about prior experience and for examples of accomplishments and methods used.

These employers tend to be the exceptions, however. Overall, there is a gap between employers' expectations and their recruiting practices. This gap presents an opportunity for employers to improve an important work process.

Recommendations

The Council developed recommendations to close the gap between employers' needs and graduates' qualifications and experience. These recommendations are addressed to universities, to employers and to the Leadership Steering Committee.

Recommendations for Universities

Colleges and universities must recognize that their two primary customers are the students themselves and the students' future employers. They must establish processes and create systems that best serve those customers in all areas of academic life, including curriculum, operations, student advising, housing, recreation, and community involvement.

Employers indicate that they want at least their graduate-level recruits to have an experiential base. Such a base should be modeled in the classroom (in all disciplines) and in the life of the institution itself, with opportunities for the development of leadership skills. Colleges and universities can integrate and support this orientation through problem-solving in team contexts, internships with quality organizations, and involvement in and administration of student and academic clubs. Colleges and universities must communicate and integrate the missions of their institutions so that every student is fully aware of what the institution contributes, not only to the individual student personally, but to society-at-large.

Throughout their academic careers, students should be made aware of and should live the concept of customer identification and satisfaction. As students of the university, they are customers; as a consumer group for food and records

and clothing, they are customers. As volunteers in community service organizations, they have customers. As work-study students in the cafeteria, they have customers, and all of these experiences, on both sides of the "counter," must be reinforced with the idea of continuous improvement and an orientation to quality and to customer service.

Specific recommendations to achieve these objectives include:

- Design a total learning experience using TQ principles to produce knowledgeable and experienced TQ graduates by:
  - ➢ Seeking opportunities for early implementation of TQ knowledge and experiences in existing curricula
  - ➢ Developing structured group learning experiences to give students practice in the integrated use of Quality tools and processes, and how to work effectively and productively in problem-solving teams
  - ➢ Demonstrating quality in the university's work processes (i.e., leading by example)
  - ➢ Involving students in university improvement projects that affect them (e.g., scheduling of classes, student advisory process)
- Develop goals, criteria and assessment plans to:
  - ➢ Evaluate student performance on group projects
  - ➢ Measure how well employers' needs are being met
  - ➢ Measure progress as an institution (e.g., by adapting the Baldrige assessment procedures)
  - ➢ Link the assessment movement to TQ
- Ensure that faculty human resource practices are aligned with TQ principles through:
  - ➢ Reward and recognition systems and tenure policies that encourage teamwork and collaboration — as well as individual faculty contributions
  - ➢ Faculty recruitment that reflects TQ principles
  - ➢ Doctoral programs (for developing future faculty members) that integrate TQ principles

- Incorporate employers' needs into placement office work process.

The Employers' Needs Working Council recommends that universities adopt TQ principles both in their curriculum and in their academic, administrative and student service activities. The Council believes that most academic institutions are far behind leading industrial and service companies in the application of TQ principles. The Council, however, wishes to encourage academic institutions to develop a TQ capability that meets or exceeds the practice of other organizations in the profit or not-for-profit sectors. Young people's first experiences will be as customers of academic institutions. If high standards of quality are established in these experiences, then these individuals will expect and demand comparable standards from all other institutions they work with either as employees, customers, or suppliers. The impact of highly demanding employees, customers, and suppliers can only produce more competitive U.S. organizations that are committed to customer service and elimination of wasteful activities.

The Council encourage academic institutions to perform a self-assessment of the current state of their TQ knowledge and implementation, and to set targets for future improvement and achievement. To facilitate the self-assessment process, the Council has developed a four-category system of classification of the state of implementation of TQ principles.

Stage 1: Apathetic (Ignorant)

Curriculum	Operations
No TQ principles taught in any course. Statistics courses emphasize statistical inference but not analysis of historic data on processes to detect patterns and trends.	Operations organized for convenience of provider, not for customer (students); Symptoms include: long lines for registration, classrooms poorly matched for class size and instructional needs, food service and housing sub-standard but expensive, complex and tedious processes to change schedule, obtain or modify grades and transcripts, difficult-to-access advisors, instructors, placement office. Limited to no application of information technology to facilitate student interactions with university facilities.

Stage 2: Technical Approaches

Curriculum	Operations
Basic principles of TQ, such as control charts, histograms, Pareto analysis, and scatter diagrams, taught in statistics courses. Quality issues mentioned but discussed only briefly (1-3 classes) in introductory operations management courses.	Modest commitment to systems for administrators to solicit complaints, concerns and suggestions from students and employees. Teaching clinics established for new instructors and for "experienced" faculty with consistent problems in student evaluations. Modest applications for information technology for students to access library, registration, placement and food service operations. University administrators deploy focused, local computer-based systems for course and room scheduling.

Stage 3: Competitive

Curriculum	Operations
All students receive some training in fundamental TQ concepts: • The seven basic TQ tools • Quality Improvement process • Problem solving process Students exposed to TQ principles in courses and in actual school working experiences: • Customer Orientation • Fact-based Decision Making • Understand Work as a Process • Working in Teams • Commitment to Improvement • Active Learning • Systems Perspective Elective courses provide (1) training and experiences with the seven Management Tools: • Affinity Diagram • Tree Diagram • Priority Matrix (2) advanced procedures, such as design of experiments, 6 σ quality, benchmarking	All university operations become customer focused with identifiable achievements in every process to: • Improve quality of services offered to customers • Reduce cycle time in delivery of services • Eliminate defects in services delivered • Increase customer satisfaction • Exploit state-of-art information technology Education process driven by commitment to: • Enhance learning • Improve teaching methods • Tailor curriculum to student and employer needs • Rapid dissemination of knowledge created in research process into undergraduate and graduate curricula Faculty rewarded for collaborative research on focused themes, that build continual, incremental knowledge. Faculty recruitment, promotion and rewards incorporate criteria that recognize value of teamwork in curriculum development, teaching, research, and administrative activities.

Stage 4: World Leader

Curriculum	Operations
TQ principles taught from students' first exposure to the educational process. Many courses, including at least one each semester for each student, stress creative problem solving in groups and active development of skills for understanding and managing interpersonal dynamics. Students wishing advanced training in TQ principles are exposed to actual experiences to apply the seven QC management tools, and design of experiments; also get exposure to quality function deployment and Hoshin Kanri planning processes.	All operations and educational processes guided by deep commitment to: • be customer focused • improve quality • eliminate waste and defects • constantly innovate, improve and learn All operations assessed and benchmarked against best practice and the evolving needs of students and employers.

Students graduating from a Stage 4 (World Leader) institution will expect and demand the highest quality processes from any organization they join as employees or transact with as customers.

Recommendations for Employers

Although the interviews and summaries indicate that employers are clear about the desirable traits of graduates, it appears that, in many cases, their recruiting systems do not support that vision. Even when that vision is supported, frequently the properly educated and oriented candidate does not exist. There must be alignment between corporate requirements, recruiting assessment tools, and the values and skills college and university graduates possess, which are shaped by the outcome of their academic lives.

One step toward achieving that alignment is for corporations to recognize that recruiting systems must be designed with their own "customer needs" in mind; they must articulate their desired qualities in recruits, and they must employ appropriate assessment tools in their recruitment processes. (Appendix C describes the values related to the eight clusters of desired orientation and knowledge; these may assist recruiters in developing appropriate interview procedures to select the best qualified candidates.) Accordingly, the Council makes the following recommendation to employers.

- Close the gap between identified needs and recruiting strategies by:
  - ➢ Building the TQ needs and expectations into recruiting practices (e.g., questioning applicants on their knowledge of and experiences with the eight "clusters" listed in Table 1).
- ➢ Offering "supplier certification" to colleges and universities whose graduate meet employers TQ needs

Recommendations for the Leadership Steering Committee

The Council also identified the need for coordination and ongoing communication that could best be facilitated by the Leadership Steering Committee. The Council therefore makes the following recommendations to the Leadership Steering Committee.

- Deploy information about employers' needs and expectations to small- and medium-sized companies, which are providing an increasing number of jobs in today's market.
- Develop a process to enable employers to provide ongoing support to universities in understanding TQ including:
  - ➢ Fostering collaborative research on Quality
  - ➢ Updating employers' needs and expectations as they evolve.

Appendix A
Employers' Needs Working Council Interview Guidelines

Purpose of the Interview

As an outcome of the third Total Quality Forum, Forging Strategic Links with Higher Education, hosted by Procter & Gamble in August of 1991, a Steering Committee and six Working Councils were formed to address the high priority agenda items identified by the participants. The Employers' Needs Working Council has agreed to determine which Total Quality principles and methodologies should be taught in universities.

To accomplish this task, one of the methods is to interview a few individuals from selected organizations with a good understanding of Total Quality. From these interviews, the Working Council will synthesize the expectations of these potential employers in hiring university graduates at both the bachelors' and advanced degree levels.

Potential employers' expectations are undoubtedly both generic for graduates in any discipline, and specific for particular degrees or disciplines, e.g., design, and manufacturing engineering, computer science, business, humanities, public administrations, etc.

Generic Expectations

What type of graduates does your company hire? What are the expectations for all graduates who are being hired? How do your expectations differ between undergraduate and graduate students?

Consider the following:

- What is the expectation for knowledge and understanding of the basic principles underlying Total Quality? What degree of familiarity with the principles is expected — basic understanding; some experience with their application in a case study; working knowledge based on actual use during course work or prior work experience?
- What is the expectation for awareness and familiarity with some basic quality tools and processes, e.g., Pareto charts, fishbone diagrams, problem solving process, benchmarking, etc? What level of skill, if any, is expected in their use and application?
- What is the expectation for having a "customer orientation," including an understanding of these concepts and their application regarding internal and external "customers" and fully satisfying their requirements?

- What is the expectation for the value of teamwork? What degree of skill is expected — basic team building experience; a well-developed skill based on substantial participation in team assignments?
- What is the expectation for understanding that work outputs are the result of a work process, and that improved results usually require an improved process? What level of familiarity and skill would be expected — understanding based on a case study; actual experience with a real application, including use of some of the basic tools? How do you assess the teamwork skills of prospective employees?
- What is the expectation for understanding and applying the concept of deploying an organization's objectives to focus resources towards their achievement?
- What are the expectations concerning:
  - ➢ values
  - ➢ leadership
  - ➢ role of the manager
- How do you assess a prospective employee with regard to each of the above?
- Any other expectations of a generic nature?
- In general, how do you assess a prospective employee's knowledge of the basic quality principles?

Expectations for specific disciplines:

To what extent do generic requirements vary for specific disciplines?

- What are the expectations for specific concepts and tools for engineering, manufacturing and service operations disciplines? Are there expectations regarding:
  - ➢ understanding customer needs and requirements;
  - ➢ the importance and techniques supporting work process improvement & process re-engineering (including reduced variability, in-process measurements, cycle time reduction);
  - ➢ knowledge and application of selected advanced tools (Taguchi methods, Quality Function Deployment, advanced statistical methods, quality assurance techniques, etc.);
  - ➢ application of benchmarking to improve Quality, Cost & Delivery performance and their impact on Customer Satisfaction;

- ➢ the value of employee involvement and empowerment, and the behaviors required to implement;
- ➢ the value of partnerships with vendors and unions, including support for just-in-time delivery and self-managing organizations;
- ➢ the use of worldwide quality standards (e.g., ISO 9000, etc.);
- ➢ the meaning of Management By Fact.

- What are the expectations for business and public service disciplines? What level of understanding is expected for:
  - ➢ the role of Total Quality in strategic planning;
  - ➢ the value and importance of becoming a market-driven organization;
  - ➢ the importance of Customer Satisfaction as a measurement and in the retention of customer by building loyalty with a repurchase mindset;
  - ➢ the application of work process improvement & process re-engineering techniques in non-manufacturing environments, including in-process measurement and cycle time reduction;
  - ➢ the use of Cost of Quality;
  - ➢ the value of partnerships with marketing/sales third parties, vendors, unions and customers;
  - ➢ the value of employee involvement and empowerment, and the behaviors required to implement;
  - ➢ the concept of high performing organizations/work processes and their impact on organization structures;
  - ➢ the role of the manger in a Total Quality organization, including the behaviors required for leadership and creation of a supportive environment;
  - ➢ the importance of employee satisfaction and the human resource techniques and practices that influence it;
  - ➢ the value of training in developing a skilled and motivated work force;
  - ➢ the meaning of Management By Fact.
- What are the expectations for sales & marketing disciplines? What level of understanding is expected for:
  - ➢ the importance and means for understanding customer requirements, especially during the prospecting and selling cycle;
  - ➢ the dynamics and selling costs of obtaining new customers vs. retaining existing customers;

- the role and uses of customer satisfaction measurement;
- the behaviors and techniques required for a customer oriented organization, including the use of incentives and other rewards and recognition practices;
- the application of work process improvement techniques in sales and marketing (e.g., market engagement, prospecting, sales order and delivery, demand forecasting, pricing, product marketing, product launch, etc.);
- the value of teamwork in a sales environment;
- the value and use of partnerships in sales distribution channels and market penetration;
- the meaning of Management By Fact.

While the above questions can operate as a guide to help structure the interviews, the purpose of the interview is to obtain insight as to what a few people who have a working knowledge of the principles of Total Quality would expect when hiring graduates for their companies. This would encompass not only their expectations upon initial recruitment but also as the graduates progress through their early assignments.

What is the appropriate balance between the learning gained during university education vs. the continuing learning that progressive companies would expect to build during an individual's career?

Appendix B

Findings by Employer

Table B-1. Employers' Needs

Employer	Awareness/ Attitude	Instrumental Skills	Interpersonal Skills	Imaginal Skills	Systems Skills
Air Force Detailed Quality career path (matrix of skills and criteria Seeking recruits with strong working knowledge and experience	Customer Focus	Knowledge of Quality principles; ability to use basic tools and measurement; ability to apply statistical methods, including Taguchi method and design experiments	Team dynamics; interpersonal skills; consulting skills; effective listening; giving and receiving feedback; coaching	Brainstorming, problem solving, story-boarding; vision (understand, implement, develop — depending on level)	Process management; strategic, systems perspective and analysis; policy deployment; strategic planning, Hoshin planning
American Express Life Assurance Company Developing new recruiting model Train all employees on Quality analysis problem solving, continuous improvement, cross-functional teamwork and customer orientation	Strong customer focus	Look for basic skills; Quality experience a plus	Team experience a plus	Problem solving skills	

Table B-1. Employers' Needs - Continued

Employer	Awareness/ Attitude	Instrumental Skills	Interpersonal Skills	Imaginal Skills	Systems Skills
American Express Travel Related Services Offer college certified courses with community college Recruit from colleges known for good Quality programs	Strong customer focus		Teamwork and leadership skills emphasized		
Analog Devices Adapting TQM to US environment Need combination of universities and industry to teach relevant skills Good results = good process + skills with tools	Listening to voice of the customer	Need for common language, set of TQ principles TQM is more skills and practice than specific techniques Graduate engineers: should learn PDCA, Root Cause Analysis; how TQM can be used to continuously improve management processes More teaching of scientific method	Need for cooperative teamwork among engineers - faculty should be role models Engineers who can deliver contributions through organizational structures, rather than working as "lone rangers"	Ability to apply problem solving tools, identify problems that are worth working "Incremental innovation": building on what existed before to meet new customer needs Tolerance for ambiguity; dealing with multiple and conflicting points of view Complex managerial and organizational problems require heavy reliance on the "in" words: intuition, instinct, invention, inspiration	Need to view work processes that can be defined, tested and improved Interdisciplinary groups working problems; longer term ability to manage cross- functional processes

Table B-1. Employers' Needs - Continued

Employer	Awareness/ Attitude	Instrumental Skills	Interpersonal Skills	Imaginal Skills	Systems Skills
Arkansas, State of Want education system to supply "trainable" people	Strong customer orientation critical	Foundation to adapt to TQM organization very quickly; basic understanding of tools and processes	Team involvement beneficial; some facilitation skills desirable; lower level of skills expected for engineering hires	Problem solving skills	
Austin, City of No internal training capability Currently rely on colleges to prepare graduates		Bachelors: Working knowledge of principles and tools, understanding of customer require-ments and measuring satisfaction Graduate: More advanced skills	Basic teamwork experience for all graduates		
Center for Quality Management Not-for-profit consortium of manufacturing companies, service organizations and universities		No obvious role for universities to teach TQM (Japanese universities do not teach) Challenge: expose students to real problems that enable them to practice Quality improvement skills		Challenge: expose students to real problems that enable them to practice problem solving skills	Challenge: Introduce total systems approach to managing organizations; future organizations will be horizontal, not vertical Manage processes that cut across traditional functions Not only how to learn, but also to teach what has been learned

Table B-1. Employers' Needs - Continued

Employer	Awareness/ Attitude	Instrumental Skills	Interpersonal Skills	Imaginal Skills	Systems Skills
Corning Training program for hiring managers Leader in building TQM into selection and recruitment; training hiring managers how to assess skills	Strong customer orientation	Basic understanding of principles, tools and processes; work process improvement knowledge for technical and manufacturing hires; working knowledge of statistics for statistical positions MBA's with work experience desirable, especially in measuring customer satisfaction	Strong expectation of working knowledge of team, interpersonal skills	Problem solving skills	
Council for Continuous Improvement (Includes input from Duncan Enterprises, Next Computer, Sandia National Laboratories, Sequent Computer Systems, Storage Tel and Teledyne McCormick Selph) Asks about prior experience and for examples of accomplishments and methods used	Customer orientation	Basic understanding of tools and processes, managing by fact; some working knowledge based on experience Higher expectations for advanced degree hires	Significant participation in team assignments	Problem solving skills brainstorming	

Table B-1. Employers' Needs - Continued

Employer	Awareness/ Attitude	Instrumental Skills	Interpersonal Skills	Imaginal Skills	Systems Skills
Federal Express Strong policy of promotion from within, so less campus recruiting Service-driven company with many customer contact points Internal training and advanced courses for management	Customer orientation and strong service attitude; focus on customer and customer satisfaction; attitude learned more through experience than classroom training Importance of values held by individual	Knowledge of quality tools		Ability to work as a member of a team	
First Chicago Each major business unit has own Quality initiative Little outside hiring "First Scholar" MBA for fast trackers Internal programs for specific skills	Strong customer focus across business units	TQM knowledge skills, experience a plus			

Table B-1. Employers' Needs - Continued

Employer	Awareness/ Attitude	Instrumental Skills	Interpersonal Skills	Imaginal Skills	Systems Skills
Henry Ford Health Care System Applicants with Quality skills have definite edge Have training capability Assess training for results	Strong customer focus	Skills included in job descriptions			
Madison, City of Has effective training capability Hiring bias in favor of those with more experience		Bachelors: Basic understanding of principles and tools Graduate: Some experience in applying principles and tools in case study	Teamwork experience	Problem solving skills	
Marriott Corporation	Customer orientation	No expectation to know TQM specifics; clear understanding of Quality from customers' point of view	Experience with teamwork	Experience with problem solving	

Table B-1. Employers' Needs - Continued

Employer	Awareness/ Attitude	Instrumental Skills	Interpersonal Skills	Imaginal Skills	Systems Skills
National Center for Manufacturing Science Achieving manufacturing excellence: detailed program that sets out requirements for manufacturing excellence and process for self- assessment					
Quality Share Group (Fidelity Investments, GTE, USAA, Harvard Community Health Plan) Recruitment should screen for desired skills			Learning should take place in team environment		Education process realigned to Quality stance vs. traditional management approach
Solectron Working with San Jose State University	Attitude of Service Customer orientation	Understanding of TQM, including statistical tools, cost of quality, Baldrige criteria; JIT manufacturing; Quality "Philosophers," learn by doing	Non-emotional communication	Problem solving skills	Quality function deployment

Table B-1. Employers' Needs - Continued

Employer	Awareness/ Attitude	Instrumental Skills	Interpersonal Skills	Imaginal Skills	Systems Skills
Westinghouse Working with universities to build in Quality principles	Strong customer orientation; understanding customers, internal and external and importance of their requirements	Understanding of basic Quality tools; difference between requirements and expectations; benchmarking Ability to map process flows Ability to quantify measures, especially in customer satisfaction	Experience in working as member of cross-functional teams	Brainstorming, problem solving skills, process improvement	View organization as system to be analyzed and improved
Xerox Corporation Trains all new hires on basic tools, Problem Solving and Quality Improvement Processes	Customer satisfaction is number one corporate priority	Basic understanding of Quality Tools and processes Understanding of work as a process that can be improved	Ability to work in cross-functional, cross-organizational teams	Brainstorming, thinking outside the box; problem solving skills	Policy deployment

Table B-2. Employers' Needs From University Challenge

Employer	Awareness/ Attitude	Instrumental Skills	Interpersonal Skills	Imaginal Skills	Systems Skills
University Challenge Compiled from review of four university Challenge courses: Carnegie Mellon University (Xerox) Purdue University (Motorola) Georgia Tech, North Carolina State (Milliken) University of Wisconsin at Madison, Tuskegee University (Procter & Gamble)	Total customer Satisfaction Quality applies to everyone all the time Requires top management commitment and leadership	Basic tools: flow charts, cause-and-effect diagram, Pareto diagram, scatter diagram, histogram control/capability charts Management and planning tools: K-J (affinity) diagram, interrelationship diagram, tree diagram, priority matrix Advanced tools: 6, planning and metrics design of experiments Benchmarking, to motivate continuous and breakthrough improvements Process quality improvement, including root-cause analysis Management by facts and data	Strong interpersonal skills for effective teamwork	Brainstorming, brain-writing Problem solving process	Work as a process Cross-functional management; ability to work successfully as part of a cross-functional team Quality function deployment (Hoshin Kanri)

Appendix C
Key Values

The world-view of a TQ recruit as defined by the eight clusters of orientation and knowledge and the related set of skills is informed by the values described in Table C-1. These values may assist college employment recruiters in developing interview guidelines.

Table C-1. Values Related to TQ World-View

Value	Definition
Mission/Quality Objectives	The ability to establish organizational goals and execute planning that takes into consideration how the organization contributes to meeting the needs of customers and society at large.
Service	To be motivated to use one's unique gifts and skills to contribute to others (e.g., customers) through one's occupation.
Rights/Respect	The principle of esteeming the worth of another as I expect others to esteem me.
Human Dignity	Consciousness of the basic right of every human being to have respect and to have his or her needs met, that will allow him or her the opportunity to develop his or her potential.
Collaboration/ Subsidiarity	The ability of a quality leader to cooperate interdependently with all levels of management to ensure the attainment of quality values and goals; such a leader not only communicates and facilitates but acts as a role model.
Cooperation	The capacity to enable persons in a corporation to work cooperatively with one another such that the unique skills and qualities of one individual supplement, support and enhance the skills and qualities of others in the group.
Interdependence	Seeing and acting on the awareness that personal and inter-institutional cooperation are always preferable to individual decision-making.

Table C-1. Values Related to TQ World-View - Continued

Value	Definition
Self-Competence/ Confidence	Realistic and objective confidence that one has the skills (tools) to achieve in a quality organization and to feel that those skills are a positive contribution.
Criteria/Rationality	The trained capacity to think logically and reasonably based on a formal body of information through the application of quality tools.
Efficiency/Planning	Designing acts and purposes employing quality tools before implementing them in the best possible and least wasteful manner.
Evaluation Self System	Appreciating objective appraisal of one's self and making application of objective standards to the operations of systems; evaluation is seen as essential for both personal and organization success and growth.
Creativity	The capacity to bring ideas into concrete reality in new ways; problem solving.
Communication/ Information	Effective and efficient transmission and flow of ideas and factual data between people, departments and divisions of an organization.
Adaptability/Flexibility	To adjust one's self readily to changing conditions and to remain pliable during ongoing processes.
Decision/Initiation	To feel that it is one's responsibility to take a course of action without external prompting; to accept empowerment.
Knowledge/Discovery/ Insight	The pursuit of knowledge through patterned investigation; continuous learning and the desire to contribute to the "learning organization"

Total Quality Curricula, Materials and Programs Working Council

Working Council Membership

Co-Chairs

Peter M. Banks
Dean, College of Engineering, The University of Michigan

Robert D. Landel
Henry E. McWane Professor of Business Administration, Darden Business School, University of Virginia

Brenda B. Sumberg
Director of Quality, Motorola University

Members

Minoo Billimoria
Dean, Ford Design Institute

Joseph C. Collier, Jr.
President, Qualtech Quality Services, Inc. (Deceased)

J. Michael Cummins
Associate Dean, External Relations, University of Miami School of Business

John P. Evans
Professor, Kenan-Flager School of Business, University of North Carolina - Chapel Hill

David Luther
Senior Vice President, Corning, Inc.

John A. White
Dean of Engineering, Georgia Institute of Technology

Carl Wolgemuth
Associate Dean, Undergraduate Studies, The Pennsylvania State University

Contents

I. Background

II. Charter

III. Benefits

IV. Methodology of the Working Council

V. Findings

VI. Six Strategies for Curriculum Enhancement

VII. Employees Needs and Responsive Curricula

VIII. Progress in Implementing TQM in Academia

IX. Recommendations

X. Conclusions

XI. Future Activities

Appendix A. Special Survey of Five Institutions

Total Quality Curricula, Materials and Programs Working Council

I. Background

In July 1992, over 550 professionals from education, industry, and government met at the Third Annual TQM Symposium at Lehigh University. Their purpose was to discuss recent developments in TQ and the applicability of TQ methods to this nation's academic enterprise. The message from participants was clear: a major TQ revolution is sweeping this country as a consequence of the realization that powerful, new, management methods offer a superior basis for organizing and operating large organizations. As a consequence of this, it is essential for the educational enterprise of this country to include TQ methods as part of their curriculum, especially for students in professions where the needs of industry play a key part in determining the topics of study. In addition, TQ offers to universities, colleges, and schools new tools to better manage their own operations.

At the Symposium, educators were told the importance of supplementing the knowledge of their graduates to include the important principles of TQ. The call was made to provide the means for faculty to become familiar with TQ as it is practiced in industry, and to develop ways to bring the basic principles into the classroom. Special emphasis was placed on doing this for business and engineering students, since these individuals would be most directly involved in the rapid changes facing industry and government.

Why TQ? One definition of TQ is ... "the unyielding and continually improving effort by everyone in an organization to understand, meet, and exceed the expectations of its customers." The concepts of TQ are the same among the engineering and business disciplines even though the tools may vary between them. They are: Customer focus, defect prevention vs. detection, work process orientation and continual improvement. In all cases, the assumption of

responsibility by individuals in organizations has been shown to result in vastly improved products and processes, whatever they may be.

It is clear that TQ has a two-fold meaning to higher education: On the one hand it offers a viable, strong system to effectively manage the complex structure of educational institutions. On the other, it is an important, new approach to organization and work operations, and knowledge about it is increasingly needed by graduates in order for them to be successful in their work place.

The benefits to education from TQ are many and are outlined in detail in this report. The effort needed to restructure an organization along TQ principles is massive, and strong leadership is required to be successful. However, the consequences of not adopting TQ are severe, and should not be casually dismissed. Just as many in today's workforce seek out industries with TQ systems in place, so will future students seek out learning institutions that are devoted to excellence that accompanies successful integration of TQ into their curricula and teaching practices.

II. Charter

The Total Quality Curricula, Materials, and Programs Council believes that the concepts underlying Total Quality should be an essential ingredient of the educational programs of this nation's business and engineering schools. While the content and methods of presentation may vary between disciplines and specific situations, and will depend upon the maturity of the students, there exist certain fundamental concepts and methodologies which are of basic importance to individuals; and, to the successful functioning of the fundamental premise that Total Quality is a basic process essential to our ability to meet the demands of international competitiveness, both in industry and in education.

This Council recognizes that its principal goals are: (1) to investigate and define the basic strategy and processes which are needed to bring Total Quality concepts into the curricula of business and engineering schools across the nation, (2) to study ways in which Total Quality study materials and processes already developed in academia can be made available to meet the needs of the colleges and universities, and (3) to study and give as examples various outstanding practices and processes of study related to Total Quality, in the expectation that these will enhance general understanding and implementation

of curriculum and program development by faculty, administrators, and others involved in business, engineering, and other related fields.

III. Benefits

The underlying premise of the following statements is that by incorporating TQ in management and engineering curricula, a special opportunity is presented to create close interactions among curriculum development, research, and business-university relationships. Objectives include the issues listed below.

- Application of TQ principles — design and delivery of a revised curriculum and operation of academic units reflect TQ principles.
- Increased customer satisfaction — the curriculum meets the long-term needs of students and organizations that employ those students.
- Reduced variability in learning outcomes — the curriculum and its delivery achieve desired learning results by the target population.
- Reduced learning cycle time — the curriculum is focused; extraneous material is eliminated; delivery is coordinated across multiple sections; unproductive redundancy is eliminated; and linkages across disciplines improve integration.
- Dynamic orientation to curriculum development — curriculum development becomes a managed process seeking continuous improvement in individual courses and in entire degree programs.

The benefits within the education community from these efforts are many:

1. Incorporation of TQ in the curriculum and operation by TQ principles serve as shared values and unifying themes for the students, staff, and faculty.
2. Students learn the basic content of TQ and they experience increased awareness of what it means to adopt a "customer orientation." Students achieve increased awareness of who their customers are, what those customers' needs are, and what processes students use to meet those needs. This builds a base for subsequent maturity with this new point of view.
3. Students will have the benefit of learning about new management methods that are being used by business and government organizations. These students thus become more attractive to employers and better equipped to work in a TQ organization or to assist an organization to implement TQ.

4. As faculty begin to act in accordance with TQ principles, they get the benefit of progress in an organization that is using these concepts for its own benefit. Students get the benefit of participating in and observing a professional work place where these values are promoted.
5. TQ provides a common vocabulary that can strengthen linkages among the activities of teaching, research, and practice (corporate and university). Research and teaching in a broad range of disciplines stand to benefit. Interactions improve with organizations that sponsor research and curriculum development.

IV. Methodology of the Working Council

The council members identified 38 universities who have been active in incorporating quality concepts into their curricula. These institutions were asked to share with this Working Council the nature of their quality curriculum endeavors (primarily using University Challenge Applications or IBM Research Grant Applications). 28 responded and many of these were contacted by phone to clarify or probe more deeply into the information that was sent.

In addition, extensive discussions were held between members on topics related to the experiences of the members, the meaning of the specific data, and progress seen in academia over the past several years. Writing assignments were accepted by members and drafts circulated to achieve group consensus.

V. Findings

General Observations. Although relatively few business and engineering programs have fully integrated TQ into their curricula, an impressive record of commitment and accomplishment has emerged in a relatively short time frame. However, it is also clear that no single approach is likely to emerge as the de facto standard for how to achieve effective integration — nor, from the perspective of the members of the Working Council, should it. Historically, a strength of the nation's business and engineering education programs has been their diversity; such diversity, even in bringing TQ to undergraduate and graduate students, is encouraged to continue. However, as institutions gain experience with alternative forms of integration, we encourage the sharing of "lessons learned" and a convergence toward a small subset of alternatives.

While some universities prefer to designate specific courses to convey to

students the "essence" and "specifics" of TQ, it is also the case that a near equal number believe that the most effective way to effect a TQ mindset in the student is to incorporate elements of TQ in a multitude of courses throughout the students' educational experience. While some are maintaining a traditional disciplinary focus, others are developing specialized degrees, options, certificate programs, or minors in TQ. While some are restricting their curricula innovations to graduate programs, others are introducing TQ to first year students. While some teach the need for cross disciplinary teams, others are practicing it by bringing together students from multiple engineering disciplines with nonengineering majors. While some engineering schools have concentrated their TQ activities in one department (usually industrial engineering), others have very strong participation from all engineering departments. Some are well along on the integration journey, others are just beginning. Some are predominantly undergraduate institutions, others are leading research universities. Some are relatively small, narrowly focused, privately financed technological institutions, others are large, comprehensive, publicly supported universities.

An issue that emerged early in the study by the Working Council was the differential needs of business schools and engineering schools. Since the "professional practice" degree in engineering tends to be the bachelors degree and the "professional practice" degree in business schools tends to be the masters degree, it became clear that expectations of the need for TQ exposure to undergraduate students and graduate students differed between business schools and engineering schools. Although much of the deliberation of the Working Council focused on undergraduate engineering programs and graduate business programs, the curricular recommendations also address undergraduate business programs.

Finally, an important finding was the relatively high priority given by industry to "soft" issues, rather than "hard" issues of TQ. Particularly noteworthy was the very high priority given to understanding fundamental processes, as opposed to the tools and techniques for improving those processes. The relative significance of process knowledge and tools/techniques should be kept in mind in reviewing the following examples of current and planned practice, as well as the recommendations concerning the integration of TQ in business and engineering curricula.

VI. Six Strategies for Curriculum Enhancement

Academic institutions that have initiated the inclusion of Total Quality practices into their curricula have identified key strategies required for success. Some of these are very consistent with the experiences of industry.

Examples of how each of the strategies have been applied in university settings will be given. These examples are by no means exhaustive but are intended to illustrate a few of the applications of which the Working Council became aware during its investigations.

1. ***Integration***

It is important that the teaching of quality be integrated within the contents of individual courses as well as across the entire curriculum. The appropriate learning cannot take place or be properly reinforced if quality is an insertion at a single point into a class or as a single course within a curriculum. This is very consistent with industry experience that the greatest success comes where quality is practiced across entire systems and in all operations.

If an academic institution has either a college of business or of engineering, quality concepts should be linked to all appropriate course content across the entire curriculum of those schools. If the institution has both colleges of engineering and business, the teaching of quality within the two schools should be integrated. This may mean teaching cross-functional classes, exchanging faculty resources or that the same topics are taught but with different objectives, i.e. one set of students may require knowledge or awareness of the concepts and another may require skill in applying the concepts.

Application examples:

- Columbia Business School. Case studies integrated across disciplines; core courses all integrated with each other.
- University of Miami Institute for the Study of Quality. Collaboration of the colleges of business and engineering to produce the seamless integration of Total Quality principles and practices into the entire curriculum of either discipline.
- University of Iowa. Planned use of interdisciplinary teams to explore team teaching using faculty from Statistics, Engineering and Business Administration as appropriate.

2. ***Practice of Quality Principles***

In order to be convincing and credible when teaching Total Quality concepts, it is important they be practiced in the context of the university. What better way

to teach than to model? The practice of total quality principles could encompass everything from continuous improvement of the administrative functions to the process for curriculum development to the teaching methods used in the classroom. This notion is very consistent with industry experience that leaders and managers must "walk the talk". Behaviors consistent with quality concepts are much more effective in advancing quality initiatives than are words saying how important it is.

The practice of quality concepts is a maturing process. The scope and institutionalization may evolve over time, but should be initiated and encouraged.

Application Examples:

- Rochester Institute of Technology. Feedback from students at the end of each class session (real time) with resultant adjustments to the next session.
- Georgia Institute of Technology. Student feedback at first session of course which resulted in changes to course syllabus and assignments; tracking and analysis of test performance to determine when the root cause of poor performance was attributable to instruction.
- University of Iowa. Continuous improvement through the use of Quality Improvement Teams in "Business Statistics" course.
- University of Chicago Graduate School of Business. Quality management activities including training programs for staff and faculty, administrative improvement processes, teaching improvements, planning and strategy development.

3. ***Customer-Focus***

Basic to Total Quality is the concept of defining quality from the perspective of the customer. (See Core Body of Knowledge Working Council Report.) Clearly then, the first requirement is to identify who the customer is. There may be multiple customers. Possible customers of a university might be: students, parents, society, government bodies, alumni, employers and faculty.

Once identified, the next step is to understand their requirements. If there are multiple customers, they will probably have some different requirements and some of these may even be in conflict.

Requirements may include things such as timeliness, responsiveness, content, ease of doing business, etc.

Application Examples:

- Columbia Business School. Initial stage of curriculum revision involved extensive research of requirements of current students, alumni, recruiters and senior corporate executives.
- All of the examples of responsiveness to student feedback.

4. ***Involvement of Stakeholders***

It is important that all stakeholders (whether considered customers or not) be involved in the learning process of Total Quality from the beginning. One of the underlying principles is that of teamwork (See Core Body of Knowledge Working Council Report) so all of the potential members of the team must be involved in order to gain their commitment and insight.

Application Examples:

- Carnegie Mellon University. Commission of Undergraduate Education composed of faculty, staff and students.
- University of Chicago. The Graduate School of Business has discovered "student power" (MBA students) to act as change agents while enhancing their own education. Individuals and teams have been involved in projects aimed at implementing TQ outside the University and within the administration of the business school. These students receive support, coaching and facilitation by committed faculty resources.

5. ***Leadership***

There is another strategy that academic institutions have found critical in developing Total Quality curricula and industry leaders have found key to successful implementation of quality systems. That is the notion of having strong, involved leadership. The role of this leader includes ensuring the formation of a vision, mission and goals for the organization; and early and continuous communication of all of the intentions, actions and accomplishments.

Application Examples:

- Rochester Institute of Technology College of Business. Establishment of Vision, Values and Critical Drives and a process for implementing them.
- University of Michigan. Development in different parts and levels of the university starting with the head of the hospital, moving to the Dean of the School of Engineering, then to the Provost for central integration and to the Dean of the Business School.

6. ***Processes for Anticipating and Responding to Future Requirements***

One of the facts of Total Quality is that, as customer expectations are met, the requirements will change. Therefore, it is important for processes to include the capacity to anticipate those new requirements and respond to them in a timely manner. It is for that reason that industry has come to understand that quality will always be a new challenge or expectation to be met. Moreover, if universities are to take on the leadership role they have played in other areas, they must be able to present new quality concepts and tools to meet the competitive requirements of their customers.

Application Examples:

No examples found. Most institutions are currently in a "catch up" mode and this area would seem to be a challenge for the future.

VII . Employees Needs and Responsive Curricula

From the early findings of the Employees Needs Working Council, we concluded that our assessment of curriculum responsiveness could be viewed within 5 categories of needs:

1. Fundamental Knowledge and Capabilities
2. "Soft-Side" of TQ
3. Advanced Levels of Knowledge and Capabilities
4. Customer-Orientation
5. Systems Perspectives

The following Table summarizes the perspectives we followed in developing many of our recommendations:

Employer Needs	Curriculum Perspectives, Issues, and Recommendations
I. Fundamental Knowledge & Capabilities • TQ principles • TQ concepts • Seven Basic Tools • Seven Management and Planning Tools • work process improvement cycle (PDCA)	All engineering students should take an introductory course in their first year of study and a cross-disciplinary design course in the senior year, with the majority of the content in the courses devoted to TQ. The introductory course should include the Seven Basic Tools, principles, philosophies, and concepts of TQ. The senior level course should include the Seven Management and Planning Tools. The introductory courses taught to undergraduate and graduate students in business should include concentrated treatment of TQ, with the Seven Basic Tools taught and the Seven Management and Planning Tools taught to all. Examples of introductory courses for engineering students include those at Cornell University and the University of Michigan, with the latter also providing a senior level required course for all engineering majors; examples of introductory courses for business students include those at the University of Iowa, University of Chicago, and the University of Miami. The teaching of TQ in core courses must be reinforced in other courses by requiring students to use the tools.
II. "Soft Side" of TQ interpersonal skills • team process and team member effectiveness as a problem-solving group experimental learning • real problems • "fuzzy" issues • "learning by doing" • "hands-on" experience	Undergraduate courses in both business and engineering schools should emphasize experiential learning sequences as a means of providing "hands-on" experiences with real problems and creating guided learning experience dealing with the issue of teamwork, interpersonal relations, and organizational effectiveness. Faculty must be ready to facilitate the learning process of effective teamwork. "Learning by doing" should be reinforced throughout the curriculum. Experience with case studies should be supplemented with exposure to real problems, either in an industrial setting or using the university as a laboratory. Open-ended, ill-defined, complex problems are preferable to relatively simple, text-book problems. Interpersonal dynamics and the challenges of working in teams should be an integral part of the experiential learning objective. The capstone design course(s) required of undergraduate engineering students should include experience in working in teams in designing products or processes.
III. Advanced Knowledge and Capabilities • design of experiments • concurrent engineering • quality function deployment • structured analysis and design	Elective courses should be provided for business and engineering majors who wish to take more advanced courses in TQ and time should be available in the curriculum to allow students the opportunity to take such courses without extending the time required to complete the degree. Advanced design of experiments, concurrent engineering, structured analysis and design tools, and quality function deployment are examples of subjects that should be available through elective courses.

Employer Needs	Curriculum Perspectives, Issues, and Recommendations
IV. Customer Orientation • customer surveys • customer-driven design • measurement systems	All undergraduate business and engineering majors and all graduate business majors should be taught the importance of a customer-focus, the need to consider the "voice of the customer" in designing products and processes, the goal of customer satisfaction, the use of customer surveys and measurement systems to ascertain customer attitudes and expectations. The capstone design course(s) taken by engineering majors is an appropriate vehicle for conveying the role of the customer in engineering design.
V. Systems Perspectives • design and implementation • enterprise modeling • systems integration • vendor-customer partnerships	Systems aspects of quality delivery should be taught in a course dealing with overall management issues, system interactions, and the integration of business functions to achieve quality objectives. Developing supplier-customer partnerships, as well as a focusing on customers' customers, and establishing information linkages via electronic data interchange are examples of issues meriting exposure to undergraduate and graduate business majors and undergraduate engineering majors.

VIII. Progress in Implementing TQ in Academia

Specific Examples of Enhancement Activities. As examples of institutions that have either effected or are in the process of effecting significant curricular enhancements to incorporate TQ, we summarize activities underway at sixteen universities and colleges. Recognizing that the institutions we cite are neither a collectively exhaustive set of institutions involved in incorporating TQ into business and engineering curricula nor necessarily represent "best practice," it is nevertheless the case that changes are occurring at these institutions, changes that merit the serious attention of the academy. Our descriptions include several where we have chosen to emphasize the nature of the curriculum enhancement process underway at the institution:

Curriculum Enhancement Process	Example
Departmental Support	Carnegie-Mellon
Student Involvement	University of Chicago University of Iowa
Integration Coordinator	Columbia University
Topics/Materials Revisions	University of Michigan Rensselaer Polytechnic Institute
Program/Faculty Team	Rochester Institute of Technology
Systematic Instructional Design	University of Miami

Consider the following examples:

1. *Carnegie Mellon University:* The Statistics Department is working with all engineering departments to design statistics courses which are better integrated into the engineering curriculum. Viewing the engineering departments as "customers," the Statistics Department is using TQ methods to improve teaching. Item response analysis of quizzes is being used to identify patterns of common student errors in improving the teaching/learning process. The university has committed to "practice what we would teach" and employ TQ to improve the operations of the university to enhance the quality of instruction (via University Teaching Centers) and to create a University Advising Center.
2. *University of Chicago:* The Graduate School of Business (GSB) has a long history of involvement with TQ from core curriculum changes in the early 1970's (e.g. SPC) to the present day school-wide involvement of employees, students, faculty, alumni and employers. Chicago's initiatives offer many examples of TQ integration into an institution, in course design and in teaching activities. Quality topics are found in nearly half of the core curriculum and the faculty offer nine quality management electives. Practitioner-oriented improvement projects are required in each elective. A major (or "core concentration") in Quality Management is available in the masters and doctoral programs of study. The management laboratories component of the Chicago curriculum permits teams of students to apply TQ in consulting situations within client companies (solve real-world problems) and to use TQ within the GSB curriculum to design new courses and improve existing courses. Student involvement is a key TQ component in the curriculum evolution and management educational experience at the University of Chicago.
3. *Columbia University:* In 1990, Columbia began a vigorous restudy of its curriculum using competitive benchmarking and customers' requirements research. Four themes were identified as fundamental components of a comprehensive graduate business education: globalization, quality, ethics and human resources. Integration of the themes throughout the core curriculum was done by the use of integrative cases, team projects and a fundamental restructuring of the core curriculum. The new core curriculum design presumes that each core course (10 equivalent semester courses) will incorporate the four themes as appropriate. TQ now appears in Managerial

Statistics, Accounting I and II, Managing Human Behavior In Organization, Managerial Economics, Managerial Finance, Marketing, Decision Models, Operations Management, The Global Economic Environment and Strategic Management of the Enterprise. Two faculty have been assigned as the school's Quality Integration Coordinators. They will assist core course designers in the task of incorporating quality in the core courses and monitoring the success of the integration effort. Columbia's goal is to have all MBA students graduating with a "deep and thorough understanding of quality management which they will use throughout their careers".

4. *Cornell University:* Although students have considerable freedom to cross organizational lines in taking courses, the university is committed to integrating TQ into the curriculum of each academic unit within the engineering college. Elective courses are being designed, along with TQ modules that will be incorporated in required courses. The mechanical and aerospace engineering, civil and environmental engineering, computer science, and operations research and industrial engineering are the most active departments. An introductory course in probability and statistics, having TQ as its central theme, is being developed and will be required of "almost all" engineering undergraduates; the course will be disseminated nationally through the National Science Foundation sponsored National Engineering Education Coalition, headquartered at Cornell. A Quality Council, chaired by the president, was established in 1991 to apply TQ in improving the operations of the university.
5. *Georgia Institute of Technology:* TQ is a required course for industrial engineering and textile engineering majors; an elective course in concurrent engineering was developed jointly with Motorola for electrical engineering majors; the aerospace engineering department teaches quality function deployment to graduate students; and the mechanical engineering department teaches QFD and concurrent engineering to undergraduate mechanical engineering students. The college has a goal of teaching TQ to all engineering students, providing all engineering majors with multiple experiences in working on teams, and developing cross-disciplinary design course for engineering majors. A Quality Council, chaired by the president, was established in 1992 to accelerate the integration of TQ into the business school and engineering school curricula and to stimulate increased application of TQ in the operation of the university.

6. *University of Iowa:* every undergraduate business and engineering student is introduced to basic statistical concepts and basic tools as they relate to quality and productivity improvement. The traditional "Business Statistics" required course was recently updated and stresses the seven basic tools and puts less emphasis on probability and hypothesis testing. The counterpart course for engineers introduces all undergraduate engineering students to the quality philosophy and statistical quality control methods. To effect multidisciplinary education, a specific set of core courses will be taught by multidisciplinary teams of faculty. Quality Improvement Teams of students are used to continuously improve required courses. A specialization in quality engineering is offered by the industrial engineering department. Since 1986, a masters level interdisciplinary degree program has been offered in quality management and productivity. In 1992, a MBA/MA with a concentration in Leadership, Quality and Team will be offered. A cross disciplinary doctoral program in TQ is available, involving the business school, statistics department, and engineering school.
7. *University of Miami:* The University of Miami Institute for the Study of Quality in Manufacturing and Service has developed eleven self-contained educational modules for use in existing engineering and business courses. The modules are discrete units of instruction showing the application of TQ principles to the functional area subject matter of the course (example modules include: product and process design, business statistics, engineering administration, advance organizational behavior, productivity engineering). As a collaborative effort between the School of Business and the College of Engineering, the Institute has developed a nineteen step "systematic instructional design" (SID) model that provides for the involvement of all relevant stakeholders in inter-disciplinary curriculum revision and learning outcomes validation. Cross functional teams of faculty will be used in the SID process to ensure that linkages between and within engineering and business curricula are included in the design of individual courses. A five-course graduate level certification program in TQ is offered and a Master of Science degree in TQ is being developed.
8. *University of Michigan:* In the College of Engineering twenty-two TQ topics were identified and existing courses were surveyed to ascertain level of coverage for engineering students. Although a significant number of engineering majors are being taught various aspects of TQ, it was concluded

that a freshman-level introductory course with one-third of the content devoted to TQ would be taken by engineering students. This introductory course will use the *TEAM Handbook* as its textbook and will include two projects which will require application to TQ. Additionally, this Fall a 3 credit hour, elective, senior level course on TQ will be offered.

In the Business School, a variety of TQ related courses are available to MBA students, together with some degree of on-the-job experiences. Twenty-eight TQ topics were identified as relevant to the learning objectives of the MBA program. Twenty of these topics are addressed in the core courses of Operations Management, Computer Information Systems, Accounting, Operations Management, Organizational Behavior/Human Resources Management, and Statistics/Management Science. A new joint program with the College of Engineering is now planned for the 1992/93 academic year, with substantial joint development of new TQ courses.

The university, as a whole, has developed a quality program (M-Quality) with the aid of an external consulting company. Emphasis has been placed on building staff quality-related programs and considerable success has been achieved in the university hospital and the Information Technology Division responsible for operating the campus-wide computer systems and the telephone network.

9. *University of Minnesota:* Faculty from the Colleges of Education, Institute of Technology and the Carlson School of Management have formed an internal consortium that concentrates upon understanding the university's existing courses and faculty teaching and research interests, assessing business executive and student needs, and developing a proposal for a professional certification in Quality. A certificate program in TQ is to be introduced in fall 1992 for undergraduate students and graduate students. Within the engineering college, an extensive set of TQ related courses is taught, with the primary emphasis being at the graduate level. The Carlson School of Management teaches courses in quality management, design of experiments and other supporting areas such as, strategy and operations and management. The primary focus of these courses is on the different management philosophies and how they impact strategy, planning and operations. At the Twin Cities campus, graduate courses are taught. Civil and mineral engineering, computer engineering, computer science, electrical

engineering, and industrial and mechanical engineering majors can take one or more courses that either touch on or are devoted entirely to TQ.

10. *Northwestern University:* In the schools of business and engineering, graduate students are able to learn from TQ industry leaders and utilize company laboratory facilities. In the business school the course, Total Quality Management, has been developed in conjunction with Motorola, Inc. (50% of the course is taught by executives from industry). In it's Masters of Management in Manufacturing Program, jointly administered by the business and engineering schools, a capstone sequence in manufacturing process and product management is required. The course sequence is built around the unifying theme of product development to meet customer needs. A major component of the course is a hands-on product development project that spans two quarters. A requirement utilizing facilities at McCormick's Manufacturing Laboratory is included in the course to provide process and software familiarization, as well as experience in using modern meteorological and statistical tools for process design and process control.
12. *Rensselaer Polytechnic Institute:* Eleven TQ topics have been identified and a plan has been developed to ensure that they are broadly distributed throughout the curriculum, including the required courses — in the Engineering Curriculum: Introductory Engineering Design and Modeling and Analysis of Uncertainty and in the Management Curriculum: Introduction to Management and Quantitative Analysis for Management. An extensive set of courses in management, general engineering, electrical, computer, and systems engineering, materials engineering, and mechanical engineering is being revised to incorporate one or more of the eleven TQ topics.
13. *Rochester Institute of Technology:* RIT's School of Business has chosen a "Quality Management Education" strategy to guide its faculty and staff in the integration of TQ into the curriculum. Beginning with the vision that focuses the school as being the "premier source of graduates fully prepared for organizations committed to TQ", the faculty used a quality focused team approach in 1991-92 to examine and revise the core curriculum requirements based on both employer and student "customer" requirements. In 1992-93 six program teams (corresponding to the existing undergraduate majors) will develop and implement course design improvements in their respective courses and work as a faculty team to be actively involved and concerned

with improving such student-centered activities as recruitment, advising, teaching and placement. A seventh program team is charged with examining the requirements and developing (if appropriate) an undergraduate major and a graduate concentration in Quality. In addition to these student-focused program design and management teams, the school has also begun transforming its committee and departmental structures and forming new processes and positions to assist with their movement toward Quality Management Education.

14. *University of Tennessee:* Faculty in the MBA Program are reconstituting the core curriculum of their MBA Program to emphasize the development of MBA graduates that are able to "continuously improve systems for the delivery of customer value, communicate effectively, manage within team-based settings, and appreciate the interactions and difficulties of managing within a functional organization". Analytical tools are taught on an as-needed basis to support the relevant modules of the curriculum re: TQ tools such as Pareto diagrams, cause and effect diagrams, affinity diagrams and force-field analysis will be utilized throughout the core courses.
15. *University of Texas at Austin:* TQ concepts, teamwork, people management, and customer satisfaction are among the topics covered in a first year introductory course taken by mechanical engineering majors. Each year, mechanical engineering majors take at least one course that emphasizes TQ, including Six Sigma concepts, statistical process control, concurrent engineering, Taguchi and factorial design of experiments, and quality function deployment. Additionally, the electrical engineering school is revising undergraduate courses to provide an exposure to TQ in semiconductor manufacturing and VLSI design. One such elective course at the bachelor level and MBA level incorporates quality management concepts and methods.

IX. Recommendations

The following recommendations are made for business and engineering majors:

1. ***Integrating TQ into the Curriculum***
   - all business and engineering undergraduate students should be exposed to the concepts of TQ (including customer-driven quality) the 7 Basic Tools, and cross-disciplinary teams.

- first-year emphasis should be on basic tools and subsequent courses should reinforce the teaching by requiring the use of the tools.
- all upper division business and engineering students should take an application-oriented course that includes the 7 Management and Planning Tools.
- cross-disciplinary experiences for engineering students should not be limited to other engineering disciplines; they should include business majors on the teams.
- continuous process improvement should be ingrained in the mind of every business and engineering student.
- course requirements for all business and engineering majors should include the opportunity for students to take elective courses in design of experiments, quality function deployment, quality planning, individual and organizational change, employee involvement management systems, statistical process control, structured analysis and design, simulation, or other advanced TQ topics.
- all upper division engineering students should take a course in concurrent engineering.
- core courses in accounting, human behavior, marketing, and operations should reinforce the TQ principles taught in earlier courses, particularly as they apply to the sub-disciplines within business schools.

2. *Experiential Learning*
   - management laboratories and design laboratories should be incorporated into required courses and project oriented field study activities should be incorporated into elective courses for all business and engineering students.
   - team experiences should take students outside the classroom and present a "hands-on" opportunity to apply TQ skills and knowledge.
   - aspects of team effectiveness — working collaboratively as a member of a small group, role playing, listening, providing feedback, team presentation — should be included as key development aspects of the learning process.
3. *Development of Educational Materials*
   - case studies should be developed jointly with industry, with an emphasis on either product development or work processes improvement and including open-ended issues.

- laboratory manuals should be developed to stimulate team-oriented, cross-disciplinary education.
- interdisciplinary case studies and teamwork projects should be a characteristic of the undergraduate and graduate curricula.
- field trips, plant tours, student internships, cooperative education programs, industry executives in-residence at the university, and industry speakers should supplement classical methods of teaching TQ; the objective should be to expose the students to the "world of professional practice" early and continuously throughout their formal education.

4. ***Improving the Teaching/Learning Process***
   - rather than obtaining feedback from students in the form of course critiques at the end of the course, institute frequent feedback throughout the course.
   - apply statistical methods to detect the presence or absence of "out of control" conditions in the education system.
   - as role models, faculty should practice TQ in the conduct of courses, performance of research, and interactions with students, staff, and colleagues.
   - the university should become a model of a TQ focused organization; in so doing, students' expectations will become the expectations of their employers.

X. Conclusions

Based on inputs received from the Working Council on Employer Needs and status reports from a wide range of business and engineering schools, it was concluded by the members of the Working Council on Curriculum and Materials that all business and engineering students should be exposed to the basic tools, concepts, and philosophy of TQ. More importantly than the basic tools, all business and engineering students should become experienced in working in teams, surveying customer needs, and pursuing continuous improvements in existing products or processes.

XI. Future Activities

The members of the Working Council have identified several actions to be taken to support the efforts of individual universities to enhance their curricula. These include:

- Resource materials to be collected at a single location and kept current.
  - ➢ TQ bibliography
  - ➢ Case studies
  - ➢ Syllabi
- Business/university partnerships to
  - ➢ Develop case studies
  - ➢ Develop or share existing teaching materials
  - ➢ Define processes for enhancing TQ curricula
  - ➢ Provide opportunities for student experiences
- Symposia to share university successful (and unsuccessful) processes used in TQ initiative
- Specialized
  - ➢ University Malcolm Baldrige Award
  - ➢ Quality audit process for universities.

Appendix A
Special Survey of Five Institutions

Of the institutions originally surveyed by the Council, five were regarded as having demonstrated substantial commitment to the development of TQ Programs. These five institutions (Indiana, Iowa, Miami, Minnesota and Texas) were personally contacted by telephone. The results of those telephone interviews are reflected in this appendix, which is intended to give more detailed information regarding these programs. A list of the contacts at these institutions is included so that those interested in more explicit information can contact the source institution directly.

Summary of Interview Information Statistics on TQ Masters Level, Certification, Specialization and Joint Programs in Engineering and Business for Special Survey Institutions

Element	U Iowa	Indiana	Miami	U Minnesota	Texas A&M
Masters Engineering Business Joint	 No Yes No	 No Yes-Proposed No	 No Yes Yes	 No No No	 No No No
Certification Engineering Business Joint	 No No No	 No No No	 No Yes No	 No No Yes	 No Yes-Proposed No
Specialization Engineering Business Joint	 Yes No No	 No No No	 Yes Yes No	 No No No	 No No No
Enrollment Engineering Business Joint	 — 12-45 Semester @ capacity —	 — ? —	 — — ?	 — — ?	 — ? —
Core Courses Engineering Business Joint	 Yes Yes No	 No Yes-Proposed No	 Yes Yes No	 Yes Yes Yes	 Yes-Proposed Yes-Proposed No
Credit Hours Engineering Business Joint	 — 3 cr. hr's per course —	 — 5 cr. hr's per course (8 week course) —	 3 cr. hr's per course 3 cr. hr's per course —	 — — ?	 — — 3 cr. hr's per course
Program Established Engineering Business Joint	 — 1986 —	 — Fall 1993 —	 — ? ?	 — — Fall 1992	 — — Proposed
Customer Response Engineering Business Joint	 — Enthusiastic —	 — ? —	 — Excellent Excellent	 — — ?	 — — ?

Overview of Special Survey Institutions: Engineering TQ Programs/Courses

Element	U Iowa	Indiana	Miami	U Minnesota	Texas A&M
Contact:	Andrew Kusiak (319)-5939	Richard Magjuka (317) 274-0874	Francis Cutler (305) 284-2404	Kevin Dooley (612) 625-0077	W. Dan Turner (409) 845-7200
Certification Enrollment Credit Hours Customer Response	No	No	No	No	No
Masters Enrollment Credit Hours Customer Response	No	No	No	No	No
Specialization Enrollment Credit Hours Customer Response	Yes - undergrad 12-45 semester @ capacity 3 cr. hr per course Healthy	No	No	No	No
Undergrad Enrollment Credit Hours Customer Response	No	No	No	No	No
Elective Courses Enrollment Credit Hours Customer Response	No	No	Yes	No	Yes-Proposed
Core Courses Enrollment Credit Hours Customer Response	Yes	No	Yes	Yes	Yes-Proposed

Overview of Special Survey Institutions: Business TQ Programs/Courses

Element	U Iowa	Indiana	Miami	U Minnesota	Texas A&M
Contact:	Andrew Kusiak (319)-5939	Richard Magjuka (317) 274-0874	Harold Gitlow (305) 284-6595	Kevin Dooley (612) 625-0077	Charles Sampson (409) 845-7115
Certification Enrollment Credit Hours Customer Response	No	No	Yes 3 cr. hr per course	No	Yes-Proposed
Masters Enrollment Credit Hours Customer Response	Yes 12-45 semester @ capacity 3 cr. hr per course Excellent	Yes-Proposed	Yes	No	No
Specialization Enrollment Credit Hours Customer Response	No	No	Yes	No	No
Undergrad Enrollment Credit Hours Customer Response	Yes Required	No	Yes	No	Yes-Proposed
Elective Courses Enrollment Credit Hours Customer Response	Yes	Yes-Proposed	No	Yes	Yes-Proposed
Core Courses Enrollment Credit Hours Customer Response	Yes	Yes-Proposed	Yes		

Overview of Special Survey Institutions: Joint Business and Engineering TQ Programs/Courses

Element	U Iowa	Indiana	Miami	U Minnesota	Texas A&M
Contact:	Andrew Kusiak (319)-5939	Richard Magjuka (317) 274-0874	Francis Cutler (305) 284-2404	Kevin Dooley (612) 625-0077	W. Dan Turner (409) 845-7200
Certification Enrollment Credit Hours Customer Response	No	No	No	Yes*	No
Masters Enrollment Credit Hours Customer Response	No	No	Yes	Yes	No
Specialization Enrollment Credit Hours Customer Response	No	No	No	No	No
Undergrad Enrollment Credit Hours Customer Response	No	No	Yes	Yes	No
Elective Courses Enrollment Credit Hours Customer Response	No	No	Yes	Yes	No
Core Courses Enrollment Credit Hours Customer Response	No	No	No	Yes	No

*Joint Program open to graduate and undergraduate students

Summary of TQ Engineering and Business School Degrees and Related Information for Special Survey Institutions

Degrees

Masters:

Engineering: None

Business: Three institutions; Iowa, Indiana-Proposed, Miami

Joint Engineering/Business: One institution; Miami

Certification:

Engineering: None

Business: Two institutions; Miami, Texas-Proposed

Joint Engineering/Business: Two institutions; Miami, Minnesota

Specialization:

Engineering: Two institutions; Iowa, Miami

Business: One institution; Miami

Joint Engineering/Business: None

Core Courses (for programs offered):

Engineering: Three institutions; Iowa, Miami, Texas A&M-Proposed

Business: Four institutions; Iowa, Indiana-Proposed, Miami, Texas A&M-Proposed

Joint Programs: Two institutions; Miami, U Minnesota

Electives:

Engineering: One institution; Miami

Business: Three institutions; Iowa, Indiana-Proposed, Texas A&M-Proposed

Joint Engineering/Business: Two institutions; Miami, Minnesota

Enrollment:

Actual figures are not available because many of the courses are new or proposed-but the general feeling across the institutions surveyed was that enrollment would be at or near capacity for the respective institutions when proposed courses were initiated and were at capacity for the ones that are already established. Overall it was felt that enrollment was "excellent".

Credit Hours:

Average of responses available across institutions surveyed was 3 credit hours per course

Customer Response:

Again, because many of the programs are proposed at this point, much of the feedback was based on the general viewpoint that overall, response was very

healthy, that is, was at or near capacity for established programs and response would be the same for proposed programs when established.

Program Established in Response to:

The customers growing awareness of the need to acquire an education in TQ to enable them to maintain competitiveness in today's world.

Program Established

Oldest program was established in 1986 and newest ones are proposed for 1992-1994.

Ranking:

Based on number of degrees/courses offered:

1. Miami
2. Iowa
3. Texas-Proposed
4. Minnesota, Indiana-Proposed

Common courses required (ranked highest to lowest)

1. TQ
2. Statistics
3. Administrative/Management
4. Design
5. Operations
6. Accounting

Curriculum Information for Special Survey Institutions on Masters Level, Certification, Specialization and Joint Programs in Engineering and Business

Indiana University

Contact:

Richard J. Magjuka (317) 274-0874 (Indianapolis office-try first) or
(812) 855-9209
Assistant Professor of Business Administration
Department of Management
School of Business 630
Indiana University
Bloomington, IN 47405

School of Business:

Masters Level:

Quality Management minor for MBA programs

Course Requirements:

Students must enroll in 4 out of 5 courses. Required:

Total Quality Management
Statistical Processing Control.

Choice of:

Quality Management in Service Organizations
New Product Development Management
Quality Management in Manufacturing

Credit hours:

Five credit hours
8 week course

Enrollment: ?

Program Established: Proposed Fall 93

Customer Response: ?

The University of Iowa

Contact:
Andrew Kusiak (319) 335-5939
Professor and Chair
College of Engineering
Department of Industrial Engineering
The University of Iowa
Iowa City, Iowa 52242

Masters Level or Certification:

- Business:
  - Graduate Elective:
    - Total Quality Management and Continuous Improvement
    - Leadership and Teams
    - Managerial Accounting Theory
  - Graduate Required:
    - Quality Improvement by Statistical Methods (proposed)
  - Masters and Graduate Elective:
    - Organizational Design, Change and Transformation
    - Individualized Ph.D. in Total Quality Management
  - Masters Required:
    - Administrative Science I & II
    - Operations Management
  - MBA/MA with Concentration in Leadership, Quality and Teams
  - Course requirements Elective:
    - Leadership and Teams
    - Organizational Design, Change and Transformation
    - Total Quality Management and Continuous Improvement
    - Negotiation and Persuasion
    - Managerial Decision Making and Problem Solving
  - Majors with Concentrations in Quality:
    - Interdisciplinary MS in Quality Management and Productivity Since 1986
    - Undergraduate Required:
      - Business Statistics
      - Introduction to Managerial Accounting/Advanced Managerial Accounting
      - Production Planning and Control
  - Credit Hours:
  - Program Established:
  - Enrollment capacity for 92-93:
  - Customer Response:
- Engineering:
  - Specialization: Industrial Engineering offers a specialization in "Quality Engineering" Required Courses
    - Quality Engineering I & II
    - Concurrent Engineering
  - Core curriculum:
    - Statistics for Engineers
  - Credit Hours: ?
  - Program Established: ?
  - Enrollment: ?
  - Customer Response: ?

University of Miami

Contact:
Harold S. Gitlow (305) 284-6595
Institute for the Study of Quality School of Business Administration
University of Miami
Coral Gables, Florida 33124

Engineering:
- Specialization in Quality Engineering Incorporated
  - Quality Engineering I
  - Quality Engineering II
  - Concurrent Engineering

Business:
- Certification:
- Graduate level Certificate Program in TQ
  - Courses:
    - Theory and Methods of TQ
    - Statistics for the real World
    - Design of Experiments
    - Voice of the Customer
    - Voice of Business
- Masters Level:
  - Graduate:
    - Interdisciplinary MS in Quality Management and Productivity
    - MBA/MA with Concentration in Leadership, Quality and Teams
    - Business/Statistics: Individualized Ph.D. in Total Quality Management
  - Elective:
    - Organizational Design, Change and Transformation
    - Leadership and Teams
    - Managerial Accounting Theory
  - Required Core Courses:
    - Administrative Science I and II
    - Operations Management
    - Statistics: Quality Improvement by Statistical Methods
- Joint Degree:
  - Joint Engineering and Business Administration Masters of Science in TQ
    - Elective:
      - Advanced Organizational Behavior
      - Business Statistics
      - Construction Planning, Scheduling and Control
      - Engineering Administration
      - Productivity Engineering
      - Methods Improvement and Work Measurement
      - Product Process and Design
      - Business Statistics
    - Required Core Courses Undergraduate:
      - Introduction to Managerial Accounting/Advanced Managerial Accounting
      - Production Planning and Control
- Credit hours: 3 cr. hr's per course
- Enrollment: ?
- Program Established: ?
- Customer Response: ?

The University of Minnesota

Contact:

Kevin Dooley (612) 625-0077
Professor, Department of Mechanical Engineering
125 Mechanical Engineering
111 Church Street, S.E.
Minneapolis, MN 55455-0111

Certification:

Cross-College Certificate in Organizational Quality Transformation
Undergraduate and Graduate Level-Open to both

Course Requirements:

Students required to take 2 of 5 of the following courses:

VoEd 5770, Training and Development: Quality Management and Productivity Improvement Theories and Practices
IEOR 5030, Quality Control and Reliability
OMS 3059, Quality Management
OMS 8059, Quality Management
OMS 5155, Methods for Quality and Productivity Improvement

plus one course each from specified courses in the areas of "Profound knowledge":

Statistics
Cognitive Psychology
Systems Theory
Organizational Behavior

Credit hours: ?
Enrollment: ?
Program Established: Fall 1992
Customer Response: ?

The Texas A&M University System

Contact:

Engineering: W. Dan Turner (409) 845-7200
Associate Dean
Texas A&M University System
Engineering Program
204 Zachry Engineering Center
College Station, TX 77843-3127

Business: Dr. Charles Sampson (409) 845-7115

Business: Proposed

Certification:

TQ Certification of Specialization Programs-Proposed

Core Courses:

MGMT 105: Introduction to Business
MGMT 363: The Management Process

Enrollment:

MGT 105: 900
MGMT 363: 2,000 junior level

Engineering: Proposed

Core Courses:

Engr 109 Engineering Problem Solving
All freshmen engineering majors 1993

Engineering: Required courses in TQ

List of Contacts for Special Survey Institutions

Indiana University
Richard J. Magjuka
(317) 274-0874 (Indianapolis Office) (Try Indianapolis First)
(812) 855-9209 (Bloomington)
Assistant Professor of Business Administration
Department of Management
School of Business 630
Indiana University
Bloomington, IN 47405

The University of Iowa
Andrew Kusiak (319) 335-5939
Professor and Chairman Industrial Engineering
College of Engineering, 4132 EB
The University of Iowa
Iowa City, Iowa 52242
Fax: (319) 335-5777
Internet: ANKUSIAK@ICAEN.UIOWA.EDU

University of Miami
Harold S. Gitlow (305) 284-6595
Institute for the Study of Quality
School of Business Administration
University of Miami
Coral Gables, Florida 33124
Fax: (303) 661-4908
Please note:
A second contact for engineering programs is:
Francis Cutler (305) 284-2404
Secretary to the Dean of Engineering

The University of Minnesota
Kevin Dooley (612) 625-0077
Professor
Department of Mechanical Engineering
125 Mechanical Engineering
The University of Minnesota
111 Church Street, S.E.
Minneapolis, MN 55455-0111
Fax: (612) 624-1398

The Texas A&M University System
Engineering Contact:
W. Dan Turner (409) 845-7200
Associate Dean
Engineering Program
204 Zachry Engineering Center
College Station, TX 77843-3127
Note: Asst. to Turner is Mary
Business contact:
Dr. Charles Sampson (409) 845-7115

Total Quality Faculty Development Working Council

Working Council Membership

Co-Chairs

Ben Bethell
Sr. Vice President, Procter & Gamble

Mike Stahl
Associate Dean, College of Business Administration, University of Tennessee

Members

Charles Hickman
Director of Projects and Services, AACSB

Thomas Keller
Dean, Fuqua School of Business, Duke University

Marta Mooney
Professor, Graduate School of Business, Fordham University

John Prados
President of ABET

James Robertson
Manager of Instructional Design for Quality, Motorola

Marcy Serratt
Director of Corporate Quality, Wal-Mart

Ernest Smerdon
Dean, College of Engineering & Mines, University of Arizona

Jack West
Vice President, ASQC

Jean Kinney
Associate Director, Corporate Quality, Procter & Gamble

Contents

Recommendations
Recommendations to the Leadership Steering Committee
Key Findings and Conclusions
Methodology
Analysis and Discussion
Appendix A Rank Order of TQ Options
Appendix B Faculty Development Working Council
Appendix C Total Quality Faculty Development Survey

Total Quality Faculty Development Working Council

The Faculty Development Working Council was charged with exploring approaches and proposing actions to accelerate the mastery of Total Quality principles among business and engineering school faculty. Fostering expertise will promote interest in total quality and facilitate teaching and research.

The Faculty Development Working Council conducted a survey of 976 deans of business and engineering schools (response rate of 53%). The survey document is in Appendix C. The deans were asked to evaluate ten different options for developing faculties' interest and skills to teach total quality. They evaluated these options using three criteria: the effectiveness of the option; the value of the option for the investment required; and the likelihood that faculty would participate in the options. In addition, council members researched existing models for faculty development on the subject of total quality through a series of interviews. Finally, pilots of the five TQM University Challenges (business and education partnerships involving eight universities and five companies) were studied. The options that the council evaluated are discussed later in the report.

This report summarizes the council's recommendations and conclusions, describes our methodology, and discusses survey results. The council's charter and membership are shown in Appendix B.

Recommendations

The Working Council's main task was to prepare recommendations for accelerating faculty development in Total Quality. The conclusions of our study suggest the following recommendations:

1. ***Education/Business Partnerships***

The success of the TQM University Challenge and the enthusiasm of deans of business and engineering schools for their schools to participate with business in

learning about total quality suggests that one of the most effective options for faculty development is education/business partnerships. Universities and businesses should form partnerships for the purpose of mutual learning about total quality. Partnerships between companies and schools with mutual interests, established relationships, or close proximity are ideal. These relationships may take a variety of forms.

All firms with the interest and expertise in total quality should be encouraged to participate in one or more of the following types of activities:

- Form partnerships with 1-2 universities for TQM University Challenge type programs. The TQM University Challenge was a program initiated by Motorola. In 1992, five companies (IBM, Milliken, Motorola, P&G, and Xerox) and eight universities (Carnegie Mellon, Georgia Institute of Technology, North Carolina State University, MIT, Purdue, Rochester Institute of Technology, Tuskegee University, University of Wisconsin-Madison) participated. Faculty visited their host company for a week for mutual learning about total quality.
- Invite faculty to study their total quality experiences (including both successes and failures).
- Invite faculty to participate in corporate training courses.
- Be responsive to requests to present quality training programs to faculty on their campuses.
- Share corporate training courses and materials with interested schools and individual faculty (videos, overheads, instructional aids, and the like)
- Assist colleges and universities to set-up and administer their own faculty and employee development programs.
- Provide highly skilled and experienced "executives on loan" to assist universities in learning about total quality.
- Provide internship opportunities for faculty.

2. ***Resource Guide***

A resource guide should be developed by December of 1993. The guide should include a bibliography; class outlines and materials; reading and teaching notes that represent "the best of" alternate approaches being used at a cross section of schools. A respected faculty member should serve as the editor responsible for collecting, selecting, and editing items to be included. The

resource guide should be self-funded and available to any interested university. It should be administered by a respected academic organization.

3. *Ongoing Faculty Development*

Universities should institutionalize (establish budgets, processes, etc...) the ongoing development of faculty that includes but is not limited to teaching total quality. Additional subjects might include: teaching and research skills, interpersonal and team skills (leading meetings, working in teams, managing projects), etc... Of particular urgency is the development in faculty of a much stronger interdisciplinary project and case study orientation to support total quality concepts.

Recommendations to the Leadership Steering Committee

The working council recommends that the Leadership Steering Committee do the following to facilitate the implementation:

1. To create a critical mass of business and engineering schools committed and equipped to teach total quality, the Leadership Steering Committee should build on the success of the 1992 TQM University Challenge by repeating and expanding business/education partnerships in 1993.
   - The committee should enroll 20-30 leading total quality firms to partner with 20-30 universities in 1993. The participating companies and universities should be encouraged to build on the experience of the pilot projects incorporating those concepts which universally worked well. In addition, some of the partnerships should be encouraged to pilot faculty internships and industry executives on loan.
   - In 1993, build broad support in the corporate and higher education community for partnerships by communicating the importance of partnerships via respected business and academic media and through respected business, education, and quality associations. Business Roundtable companies should be asked to support this effort.
   - Endorse the concept of education/business partnerships through the communications activities of the committee.
2. The committee should ask a respected academic organization to produce and distribute a resource guide.

Key Findings and Conclusions

The overriding conclusion of the study is that the quality message is getting through. Business and engineering schools deans are increasingly concerned about the issue and are eager to educate faculty to teach total quality. Three options for faculty development were consistently ranked high by the deans responding to the survey:

- Industry executives on loan to a university
- Education/business partnerships
- A resource guide (references, syllabuses, bibliographies, etc..)

Each is discussed in more detail later in this report.

In addition a number of themes emerges from the working council's analysis of survey data and interviews.

1. ***Business Participation in Faculty Development Processes is highly valued.***

Schools want to work with business to learn about total quality, preferably in the form of mutually beneficial partnerships. Many schools lack expertise in the subject matter. For now, total quality expertise resides primarily in the business community. The speed with which business can provide this help will largely determine how fast faculty become proficient in total quality. Business benefits from shared learning about total quality (and other subjects) with faculty and from the opportunity to recruit employees who are educated in those total quality concepts that business finds so vital. A shared commitment to continual learning by both business and education provides a solid basis for building relationships.

The 1992 TQM University Challenge provides a useful model for establishing partnerships. A critical mass of faculty are invited to visit a company for 4-5 days for the purpose of studying their total quality practices. The participants interact with company employees, examine company case-studies, review total quality education and visit different company sites. Following the initial experience, an ongoing relationship with the company for continual learning about total quality that is mutually beneficial can be established. This could include sharing of total quality education, opportunities for faculty to observe and participate in the practice of total quality in the company, etc.

Other options for joint business and education experiences should be considered and may be preferable for some colleges and universities and businesses. Deans cite "industry executives on loan" as an option they highly value. In addition, businesses can invite faculty to study their total quality

experiences (including both successes and failures). They can invite faculty to participate in corporate training courses at the place of business or on campus. Businesses can share corporate training materials with interested schools and individual faculty; and, can assist colleges and universities in setting up their own faculty and employee development programs. Finally, businesses should consider providing opportunities for faculty internships.

2. ***Long term, colleges and universities must develop new approaches to faculty development.***

In the long term, business and engineering schools must work together to devise, implement, and test cost effective approaches to transfer total quality knowledge from business to colleges and universities. While close collaboration with business should always be encouraged, dependency on cooperative arrangements as the key source for faculty development should not be encouraged as a long-term strategy.

3. ***Faculty development processes should focus on both process and content.***

Total quality requires new behaviors and attitudes. The Curricula Working Council and Employers' Needs Working Council conclude that "role-modeling" total quality in the classroom and some experiential learning about total quality is important. Faculty will in many cases need new and innovative approaches to educate students about certain aspects of total quality (e.g. teamwork, cross-functional management, etc...). This requires an investment in developing the education and skills of faculty to effectively implement these new approaches in the classroom.

Faculty development in total quality requires new teaching models, suitable for academic settings that encourage "mutual learning" and build mastery by developing skills. Academic tradition favors individual learning and is suspicious that courses that feature skill building lack rigor. Learning is viewed as a three stage process in which knowledge is first presented, then understood, and finally practiced.

Total Quality experts, such as MIT's Shoji Shiba, insist that the conventional academic model won't work for teaching total quality. New models are needed that promote teamwork and "learning by doing". Total quality is different from conventional subjects in that it must be learned through mutual learning and must be practiced to be understood. Professor Shiba explains that for learning total quality "understanding follows practice."

In particular, effective integration of TQM concepts into university curricula in business and engineering cannot be accomplished through piecemeal addition of courses or courses materials. Just as in industry, a massive culture change in the university environment will be required. Successful implementation of TQM concepts requires strong teamwork skills, the ability to communicate effectively across disciplines and functions, and an understanding of the interrelationship of technical and non-technical factors in management decisions. Yet in the academic world, both faculty and student reward structures emphasize individual achievement and narrow disciplinary specialization — values that are antithetical to the total quality philosophy. (It may be observed that this is not unlike the functional specialization that plagues much industrial practice.)

Faculty development for total quality must be directed toward refocusing curricula much more strongly toward projects and case studies, with interdisciplinary teams of business and engineering students and faculty working on projects that integrate development, design, manufacturing, and marketing of quality products and processes. Most important of all, the reward structures for faculty and students must be altered to support this orientation, if education for total quality is to survive and flourish.

4. ***Designing Faculty Development Processes.***

The council's analysis surfaced three characteristics in addition to cost that should be considered in designing faculty development processes. Seemingly, deans prefer programs that (a) involve cooperative arrangement in which business is involved in the program design and presentation; (b) stress active rather than passive participation by faculty; (c) mix business and engineering faculty (where possible) rather than keeping them separate.

The council's analyses of existing faculty development processes confirmed that these factors are important. Furthermore, the Employer's Needs Working Council and the Core Body of Knowledge Working Council reinforce that key concepts of total quality include "having a systems perspective" and "working across functional boundaries." By it's very nature total quality is cross-disciplinary. Faculty development processes that are cross-disciplinary would logically be important.

5. ***Universities need to institute continuing education and skill development processes that extend beyond the concepts of total quality.***

The need for continuing education and skill development for faculty extends beyond the concepts of total quality. As with all organizations there is a need for

education and development on the skills that are important to the success of the enterprise.

Business and engineering schools should supplement long-standing faculty development practices and create new processes and systematic approaches that are favored by leading businesses and advocated by business schools. Schools usually depend on individual faculty to determine and arrange their own education and training needs. As one business dean explained, "We treat our faculty pretty much as independent contractors. It's their job to stay current." The TQM University Challenge experience, as well as some experiences on campuses, reinforces that faculty value development opportunities that are "not traditional."

Methodology

The Faculty Development Working Council held its first meeting at Procter & Gamble Headquarters in Cincinnati on May 12, 1992. At that meeting, the committee developed a framework for its work and established a tentative timetable for completing various tasks. In line with the Total Quality principle of assessing customer needs, the Council determined that it should obtain information from the deans of business schools and engineering schools in the United States regarding alternative approaches. Subsequent to the first meeting of the Council, a questionnaire was designed with the assistance of survey experts from Procter & Gamble. This questionnaire was approved by the Council as provided in Appendix C. This survey of university business school and engineering school deans collected information on ten alternatives for promoting Total Quality development. The ten TQ alternatives presented to the deans were as follows:

1. Senior executive on loan to the university;
2. Senior faculty member (TQ expert) on loan;
3. Faculty internships (faculty in residence with industry);
4. Teleconferences;
5. Total Quality institute;
6. Total Quality partnerships;
7. Conferences;
8. Total Quality education;
9. Total quality workshops;
10. Total Quality resource guide.

Please refer to the complete questionnaire in Appendix C for the exact questions and the description of each alternative given to the deans.
For each TQ alternative, the deans provided information on:

1. Perceived effectiveness of the alternative,
2. Likelihood of faculty participating in the alternative, and;
3. The perceived value of the alternative in relation to its cost.

The questionnaires were mailed to all U.S. business and engineering school deans. A total of 979 questionnaires were mailed, and 515 questionnaires were returned. (A return rate of 53%). Since there are over twice as many business schools as engineering schools, approximately 70% of the questionnaires went to business school deans and 30% to engineering school deans.

In addition, council members researched existing models for faculty development on the subject of total quality through a series of interviews. Finally, pilots of the five TQM University Challenges (education/business partnerships involving eight universities and five companies) were studied.

The results of the surveys, interviews, and TQM University Challenges were carefully reviewed by the Working Council at its second meeting in Cincinnati on August 5, 1992. The following section provides a description of the results of the survey and the analysis by the Working Council.

Analysis And Discussion

The results of the questionnaire resulted in a seven-point scale with the highest degree of effectiveness, likelihood of faculty participation, or value given the highest score — a "seven." If the approach proposed was judged not to be effective or of poor value, the score was "one." When the respondent was not sure, the score was "zero" so it did not enter into the mean numerical scores.

Perhaps most noteworthy is the responses of the deans regarding the importance of teaching Total Quality. Ninety-four percent of the business school respondents and 85% of the engineering school respondents scored the importance of teaching Total Quality as "extremely important" or "very important." The deans believe faculty do not place as high of importance on teaching Total Quality as they do. They conclude that only 38% would rate teaching Total Quality as extremely important or very important. Nonetheless, 80% of the business school deans indicated they felt the faculty would judge teaching Total Quality as "extremely important," "very important," or "somewhat important." For the engineering deans, that figure was 65%. Therefore,

according to the deans' estimates, a substantial majority of the faculty placed the teaching of Total Quality in the curriculum as being important.

Another interesting outcome concerned the deans' opinions on whether business and engineering school faculty should jointly participate in the same faculty development process to learn more about Total Quality. Of those institutions with both business and engineering schools, 83% of the business school deans and 83% of the engineering school deans felt that a program where business and engineering faculty jointly participated in the faculty development program was appropriate. This seems to clearly suggest that both the business and engineering deans felt that the synergism provided by joint faculty participation in the process was an advantage.

Of the ten alternative approaches to faculty development for teaching Total Quality, there were no clear-cut winners or losers. Regarding the "effectiveness" of the various individual approaches, the combined business and engineering deans' scores ranged from 4.45 up to 5.40. Since 4.0 is a neutral assessment, scores above 4.0 indicate a positive judgment regarding the value. On the likelihood of faculty to participate in the various approaches, the scores range from 4.23 to 5.09. And finally, on the value of the approach in relation to the costs to the universities, the scores ranged from 3.79 to 5.71. The rank order of the ten TQ faculty development options is presented in Appendix A.

In general, the "industry executive on loan" approach stood out as the top winner in virtually every category of analysis. The Total Quality partnerships, Total Quality education, Total Quality workshops, and faculty internships also scored well. Regarding value, the resource guide scored quite high.

The Working Council recognizes that to be effective in faculty development, large numbers of business and engineering faculty in the United States must have the opportunity to participate and benefit from the programs. Therefore, we do not believe that any single approach will provide the answer. Depending on individual circumstances, all of the ten approaches offer potential for being an effective part of a broad-based TQ faculty development program.

In the paragraphs that follow, we provide a brief discussion of the pros and cons of each of the ten approaches. These are listed in rank order according to the "effectiveness" scores using the combined results of the business school and engineering school deans.

1. *Industry Executive on Loan*

This approach is envisioned as involving an industry executive with knowledge and experience in implementing Total Quality work. This executive would work on site with a college or university for a period of six to twelve months to provide education on Total Quality to the faculty, as well as providing on-going consulting as Total Quality approaches are integrated into the curricula. This approach scored the highest ranking. It is low in cost to the universities, and little risk of failure is perceived by the deans if the businesses/industries provide top-quality executives. The executive should have hands-on experience in Total Quality and should be able to cite the advantages and pitfalls based on personal experience.

While this approach appears to be an excellent one, there are several serious constraints. First, the Working Council recognizes that corporate support may not be as high as presumed, and the number of executives that industry would provide to universities may be much less than desirable. With corporate workforce reductions, many corporations will likely be reluctant to provide the personnel needed for this approach to have widespread impact. Also, if the executive plays the role of the faculty, as opposed to teaching the faculty regarding procedures, there may be disappointment. The possibility of using retired corporate executives for this could compensate for the corporate workforce reduction issue and should be actively explored.

2. *Total Quality Partnerships*

In this approach, a critical mass of the faculty of a business or engineering school, preferably both, would visit a company for four-five days to learn about Total Quality. The faculty participants would interact with company employees in a company setting, looking at case studies and the company approach to Total Quality, and hopefully visit different company sites. This would lead to an on-going relationship of the faculty with the corporate personnel, and perhaps result in follow-up sharing of TQ education activities through company classes, seminars, lectures, etc. This is a proven approach in that it is patterned after the Total Quality University Challenge which resulted from the 1991 Total Quality Forum.

Although this is a proven approach based on feedback from the Total Quality University Challenge programs of the past year, it is quite resource intensive for industry, requiring a substantial investment of effort to organize and conduct the sessions. Industry, however, does benefit through participation in a mutual

learning experience. Perhaps the programs could be modified to reduce the resources required. For broad impact nationwide in the business and engineering schools, a much broader corporate support base must be developed. We believe that an effort should be made to build the corporate support base for this program to 20 or 30 companies willing to participate. These corporations could develop a strong Total Quality on-going partnership with schools, and continue to provide follow-up joint activities to maximize the synergism between corporate and university approaches to Total Quality.

3. ***Total Quality Education***

In this program, faculty would attend a two or three-day Total Quality course on campus (typically involving 25 participants per course) that is patterned after the TQ programs that Total Quality corporate leaders normally provide their own employees. No doubt minor modifications should be made for the academic participants to make the experience more relevant. This Total Quality education would be provided directly by the companies, professional associations, or appropriate consultants qualified to provide Total Quality education information to businesses. This would essentially be off-the-shelf modules. It can be quite flexible and has low cost.

Although this approach can be effective in providing good education for a faculty development in selected aspects of Total Quality, it is not likely that this program alone would provide a sufficiently broad-based program to meet all of the needs that the faculty have to improve the teaching of Total Quality. Still, this approach is a low-cost approach which could be of extreme value to the universities. The modules and materials provided could include systematic instructional design procedures, and steps that could be of high value to the faculty.

4. ***Total Quality Workshops***

Envisioned here are workshops sponsored by academic accreditation organizations, such as the American Assembly of Collegiate Schools of Business and the Accreditation Board for Engineering and Technology, which focus on issues of importance in implementing Total Quality throughout the curricula. Issues such as strategic planning, processes to improve faculty performance, measuring performance, analysis of faculty reward structure, benchmarks, etc. could be included. Since both the business school and engineering school accrediting agencies are interested in fostering effective teaching of Total Quality principles in the curricula, this approach could be tied to the accreditation

process. For it to be maximally effective, however, industry should be directly involved if at all possible. We believe the key link of industry with universities is an important element for success and should be included in all of the approaches whenever possible.

5. ***Faculty in Residence in Industry (Internships)***

Here, faculty members would spend from one to four months at a leading Total Quality corporation, or at an appropriate college/university where Total Quality has been effectively integrated into the curricula, in order to study their Total Quality practices. This approach could be quite effective, but it is essential that both the faculty member and the participating industry both perceive that they will benefit if the program is to be successful and gain popularity.
This program is rather labor intensive, which is a disadvantage, but the industry could benefit by having the faculty member at its location. The preliminary data from the University Challenge experience of last year support the value of this approach. It could be tied to the sabbatical leave program of the universities. Here, the sabbatical leave would be in industry with its purpose to help the faculty learn about industry practices in Total Quality. We recognize that the numbers of faculty that can be involved in such a program would be rather small nationwide, so this program is one of limited access.

6. ***TQ Resource Guide***

The notion of establishing a TQ resource guide which would include class outlines, materials, reading and teaching notes which represent best approaches is one with good value and relatively low cost. It is believed that a qualified faculty member could serve as an editor for such a guide, further reducing the cost of such an approach. This is an approach that could be extremely useful as Total Quality practices on campus are expanded and increasing numbers of faculty are engaged in self-learning regarding the approach. The "TQ resource guide" approach could be tied to the accrediting agencies, or other associations, to help promote it. Based on its good value and low cost, we believe it should be promoted.

7. ***Senior Faculty Member on Loan***

Here we envision a senior faculty member from a college or university in the U.S., or perhaps Japan, who has knowledge and experience with Total Quality who would work with a participating college or university for six to twelve months to provide education on Total Quality to faculty and on-going consulting as Total Quality is integrated into the curricula. This is a program that could be

very effective, but it would be limited because of the few numbers of qualified senior faculty who might be available for such a program. Moreover, it does not address the industry linkage which we consider to be very important, and that is another potential weakness of the program. However, the main weakness of this program is the small number of people available to participate, with the result that it could not have broad-based impact at the many universities that need to be involved.

8. ***Teleconferencing***

Here, a series (3-5) of two hour broadcasts aimed at establishing threshold awareness of TQ and its implications for national economic competitiveness would be developed. These could provide the basic steps to be taken to incorporate Total Quality principles in the curricula. Teleconferencing is an approach that has broad potential, but it can be a dismal failure if the material development is not done well and the presentations professionally made. This approach also tends to be passive, and we believe that interactive approaches are much better. While the teleconferencing approach would require a great deal of work, it does have potential and should be encouraged when all of the necessary conditions for success have been met.

9. ***Total Quality Institute***

Here the Council envisions a one-week session sponsored by the American Assembly of Schools of Business and the Accrediting Board for Engineering and Technology in cooperation with the University of Tennessee be developed to teach Total Quality to the faculty. The University of Tennessee has been involved in these kinds of workshops and is held in high regard by industry for its work in Total Quality. The objective is to build awareness of Total Quality concepts, identify Total Quality research issues, and expose faculty to alternative approaches for incorporating Total Quality concepts into the curricula and to develop action plans for each campus. Sessions would be taught at various locations and involve outstanding senior scholars and industry executives, as well as University of Tennessee faculty. This approach offers the opportunity for up-to-date faculty training. To be successful it should have the strong involvement of industry on the faculty. It is perceived to be a good idea, but is somewhat costly to develop the materials.

Perhaps such an approach could be taken to regions to minimize faculty travel and reduce the cost. For this to be totally successful, a broad base of industry support is needed since significant corporate contributions were part of the

package envisioned. The accrediting agencies and the University of Tennessee that proposed this are engaged in further refinement of this approach.

10. *Conferences*

This approach would involve conferences in which from 200 to 800 faculty participants would attend programs sponsored by higher education organizations, Total Quality organizations, and business associations. It would provide an opportunity for large numbers of faculty to learn about Total Quality. The approach was scored low, relative to the other approaches, although as mentioned before, none of the approaches were scored negative (less than 4.0) as regards effectiveness. Conferences are standard ways of disseminating new information in the university setting, and conferences relating to Total Quality potentially could be quite effective. The Council believes that if the demand is there, such conferences will emerge and no overt action is needed by this group at this time.

Rank Order of TQ Options (scale of 1-7)

Effectiveness

Total Deans	
Industry Executive on Loan	5.40
TQ Partnerships	5.02
Total Quality Education	4.99
Total Quality Workshops	4.95
Faculty Internships	4.95
Resource Guide	4.72
Senior Faculty Member on Loan	4.65
Teleconferences	4.58
Total Quality Institute	4.56
Conferences	4.45

Business School Deans	
Industry Executive on Loan	5.54
Total Quality Workshops	5.16
Total Quality Education	4.99
Faculty Internships	5.00
TQ Partnerships	4.90
Teleconferences	4.80
Senior Faculty Member on Loan	4.74
Resource Guide	4.77
Conferences	4.65
Total Quality Institute	4.47

Engineering School Deans	
TQ Partnerships	5.30
Industry Executive on Loan	5.11
Total Quality Education	4.97
Faculty Internships	4.83
Total Quality Institute	4.73
Resource Guide	4.62
Total Quality Workshops	4.47
Senior Faculty Member on Loan	4.45
Conferences	4.02
Teleconferences	4.02

Likelihood to Participate

Total Deans	
Industry Executive on Loan	5.09
TQ Partnerships	4.65
Resource Guide	4.67
Faculty Internships	4.58
Total Quality Education	4.50
Senior Faculty Member on Loan	4.38
Total Quality Workshops	4.42
Teleconferences	4.34
Conferences	4.24
Total Quality Institute	4.23

Business School Deans	
Industry Executive on Loan	5.26
Resource Guide	4.76
Faculty Internships	4.66
Total Quality Education	4.54
Total Quality Workshops	4.63
TQ Partnerships	4.62
Teleconferences	4.55
Senior Faculty Member on Loan	4.42
Conferences	4.43
Total Quality Institute	4.23

Engineering School Deans	
TQ Partnerships	4.70
Industry Executive on Loan	4.71
Resource Guide	4.45
Faculty Internships	4.41
Total Quality Education	4.41
Senior Faculty Member on Loan	4.27
Total Quality Institute	4.22
Total Quality Workshops	3.95
Teleconferences	3.88
Conferences	3.80

Value in Relation to Cost

Total Deans	
Industry Executive on Loan	5.71
Resource Guide	5.28
TQ Partnerships	4.83
Teleconferences	4.42
Total Quality Workshops	4.42
Faculty Internships	4.41
Total Quality Institute	4.19
Conferences	4.11
Total Quality Education	3.87
Senior Faculty Member on Loan	3.79

Business School Deans	
Industry Executive on Loan	5.80
Resource Guide	5.39
TQ Partnerships	4.77
Teleconferences	4.65
Total Quality Workshops	4.59
Faculty Internships	4.52
Conferences	4.32
Total Quality Institute	4.13
Senior Faculty Member on Loan	3.92
Total Quality Education	3.79

Engineering School Deans	
Industry Executive on Loan	5.52
Resource Guide	5.03
TQ Partnerships	4.97
Total Quality Institute	4.30
Faculty Internships	4.17
Total Quality Education	4.06
Total Quality Workshops	4.06
Teleconferences	3.92
Conferences	3.65
Senior Faculty Member on Loan	3.53

Appendix B

Faculty Development Working Council

Charter

The Faculty Development Working Council will analyze existing processes for building the understanding and skills of faculty to teach total quality. The council will recommend approaches for developing the understanding, skills, and processes to teach total quality focusing initially on business and engineering schools. These recommendations which may include different pilot programs, should be implementable no later than 1993.

Membership

Co-Chairs

Ben Bethell
Sr. Vice President, Procter & Gamble

Mike Stahl
Associate Dean, College of Business Administration, University of Tennessee

Members

Charles Hickman
Director of Projects and Services, AACSB

Thomas Keller
Dean, Fuqua School of Business, Duke University

Marta Mooney
Professor, Graduate School of Business, Fordham University

John Prados
President of ABET

James Robertson
Manager of Instructional Design for Quality, Motorola

Marcy Serratt
Director of Corporate Quality, Wal-Mart

Ernest Smerdon
Dean, College of Engineering & Mines, University of Arizona

Jack West
Vice President, ASQC

Jean Kinney
Associate Director, Corporate Quality, Procter & Gamble

Appendix C

Total Quality Faculty Development Survey

Total Quality has been defined in many different ways. For the purpose of this survey, we'd like to offer the following definition:

Total Quality is a customer focused system that aims at continual increase of customer satisfaction at continually lower real cost. It is a systems approach and an integral part of high-level strategy. It works horizontally across functions and departments; involves all employees, top to bottom; and extends backwards and forwards to include the supply chain and the customer chain.

To begin, please indicate how important: a) you personally; and b) your business school (engineering school)* faculty feel it is to teach the principles and methods of Total Quality (TQ) at your business school.

	Myself	Faculty Members
Extremely important to teach TQ principles/methods	❑ 1	❑ 1
Very important to teach TQ principles/methods	❑ 2	❑ 2
Somewhat important to teach TQ principles/methods	❑ 3	❑ 3
Not very important to teach TQ principles/methods	❑ 4	❑ 4
Not at all important to teach TQ principles/methods	❑ 5	❑ 5
Don't know level of importance among business school faculty		❑ 6

To date, the Total Quality Leadership Steering Committee referred to in Mr. Pepper's cover letter has been working to develop programs that are intended to better prepare faculty members to teach TQ principles and methods.

This survey focuses on several different approaches that have been developed and, in some cases, pilot tested on a small scale. Any or all could eventually be implemented. Shown below and on the following pages are descriptions of these approaches. We would like you to read each description and then give us your candid responses via the questions that follow each one. (NOTE: Even if you and/or your business school faculty do not support teaching TQ principles, your evaluation of the different approaches would still be of great value.)

---

* The survey was customized to reflect the respondents affiliation with a business or engineering school.

Industry Executive on Loan:

An industry executive with knowledge and experience in implementing Total Quality would work on-site with a college or university for a 6-12 month period to provide education on Total Quality to the faculty and provide on-going consulting as Total Quality is integrated into the curricula.

Cost to the College/University: Funding for office space, telephone and other overhead expenses.

Cost to Industry: Executive's Salary

a. How effective do you believe the above approach would be in developing your business school faculty's interest and skills to teach TQ?

Extremely Effective			Average Effectiveness			Not at all Effective	Not Sure
7	6	5	4	3	2	1	0

b. How likely do you feel your faculty would be to attend/participate in the above approach?

Extremely Likely			Might/ Might Not			Not at all Likely	Not Sure
7	6	5	4	3	2	1	0

c. Given the cost to the college/university for this approach, how would you rate its value to the college/university?

Great Value			Average Value			Poor Value	Not Sure
7	6	5	4	3	2	1	0

Senior Faculty Member on Loan:

A senior faculty member from a college or university in the U.S. or Japan who has knowledge and experience with Total Quality would work at the participating college or university for a 6-12 month period to provide education on Total Quality to faculty and on-going consulting as Total Quality is integrated into the curricula.

Cost to the College/University: Funding for the faculty member's salary, travel expenses, office space, telephone and other overhead expenses.

Cost to Industry: None

a. How effective do you believe the above approach would be in developing your business school faculty's interest and skills to teach TQ?

Extremely Effective			Average Effectiveness			Not at all Effective	Not Sure
7	6	5	4	3	2	1	0

b. How likely do you feel your faculty would be to attend/participate in the above approach?

Extremely Likely			Might/ Might Not			Not at all Likely	Not Sure
7	6	5	4	3	2	1	0

c. Given the cost to the college/university for this approach, how would you rate its value to the college/university?

Great Value			Average Value			Poor Value	Not Sure
7	6	5	4	3	2	1	0

Faculty Internships:

Individual faculty members would spend 1-4 months at a leading Total Quality company or college/university studying their TQ practices.

Cost to the College/University: Funding for faculty member's salary.

Cost to Industry: Funding for overhead expenses (office, telephone, etc...) and faculty member's living expenses.

a. How effective do you believe the above approach would be in developing your business school faculty's interest and skills to teach TQ?

Extremely Effective			Average Effectiveness			Not at all Effective	Not Sure
7	6	5	4	3	2	1	0

b. How likely do you feel your faculty would be to attend/participate in the above approach?

Extremely Likely			Might/ Might Not			Not at all Likely	Not Sure
7	6	5	4	3	2	1	0

c. Given the cost to the college/university for this approach, how would you rate its value to the college/university?

Great Value			Average Value			Poor Value	Not Sure
7	6	5	4	3	2	1	0

Teleconferences:

A series (3-5) of two hour broadcasts aimed at establishing threshold awareness of TQ, its implications for national economic competitiveness, and some basic steps that can be taken to incorporate TQ into the curricula will be presented.

Cost to the College/University: $1,000 per university plus equipment charges if not currently available.

Cost to Industry: $100,000

a. How effective do you believe the above approach would be in developing your business school faculty's interest and skills to teach TQ?

Extremely Effective			Average Effectiveness			Not at all Effective	Not Sure
7	6	5	4	3	2	1	0

b. How likely do you feel your faculty would be to attend/participate in the above approach?

Extremely Likely			Might/ Might Not			Not at all Likely	Not Sure
7	6	5	4	3	2	1	0

c. Given the cost to the college/university for this approach, how would you rate its value to the college/university?

Great Value			Average Value			Poor Value	Not Sure
7	6	5	4	3	2	1	0

Total Quality Institute:

A one week session sponsored by AACSB (American Assembly of Collegiate Schools of Business), ABET (the Accreditation Board for Engineering and Technology), and the University of Tennessee for teams of college/university administrators and faculty. The objectives are to build awareness of TQ concepts, identify TQ research issues, expose alternative approaches for incorporating TQ concepts into the curriculum and provide a forum to develop an action plan for their own campus. The session would be taught by the University of Tennessee faculty, industry executives and senior scholars from around the world. Sessions would be available in Knoxville, Tennessee and at a West Coast location.

Cost to the College/University: $550 per person for materials and lodging plus transportation.

Cost to Industry: $500,000 to cover the development costs for the institute and speakers' time and travel expenses.

a. How effective do you believe the above approach would be in developing your business school faculty's interest and skills to teach TQ?

Extremely Effective			Average Effectiveness			Not at all Effective	Not Sure
7	6	5	4	3	2	1	0

b. How likely do you feel your faculty would be to attend/participate in the above approach?

Extremely Likely			Might/ Might Not			Not at all Likely	Not Sure
7	6	5	4	3	2	1	0

c. Given the cost to the college/university for this approach, how would you rate its value to the college/university?

Great Value			Average Value			Poor Value	Not Sure
7	6	5	4	3	2	1	0

TQ Partnerships:

A critical mass (35%-75%) of faculty members from business and/or engineering schools would visit a company for 4-5 days with the purpose of learning about Total Quality. The participants would interact with company employees, examine company case studies, review company TQ education, and visit different company sites. Following the initial experience, an ongoing relationship with the company for continued learning about Total Quality would be established. This would include sharing of TQ education via the company's classes, seminars, lectures, etc.; opportunities for faculty to observe and participate in the practice of TQ at the company; etc... The college/university might find it helpful to appoint a faculty member to act as a coordinator and resource to this effort.

Cost to the College/University: Transportation costs (estimated to be $100-$300 per person) to the facility where the faculty will participate in the 4-5 day experience and some limited follow-up travel and lodging expenses.

Cost to Industry: Development costs and lodging expenses at the company location ($140,000-$250,000) for the faculty visit plus ongoing travel expenses to visit the college/university.

a. How effective do you believe the above approach would be in developing your business school faculty's interest and skills to teach TQ?

Extremely Effective			Average Effectiveness			Not at all Effective	Not Sure
7	6	5	4	3	2	1	0

b. How likely do you feel your faculty would be to attend/participate in the above approach?

Extremely Likely			Might/ Might Not			Not at all Likely	Not Sure
7	6	5	4	3	2	1	0

c. Given the cost to the college/university for this approach, how would you rate its value to the college/university?

Great Value			Average Value			Poor Value	Not Sure
7	6	5	4	3	2	1	0

Conferences:

Faculty would attend conferences of 200-800 participants sponsored by higher education organizations, Total Quality organizations, or business associations to learn about Total Quality. The conferences would feature discussions about research and case studies on Total Quality.

Cost to the College/University: $350-$500 conference fee plus travel and lodging expenses.

Cost to Industry: $300-$500

a. How effective do you believe the above approach would be in developing your business school faculty's interest and skills to teach TQ?

Extremely Effective			Average Effectiveness			Not at all Effective	Not Sure
7	6	5	4	3	2	1	0

b. How likely do you feel your faculty would be to attend/participate in the above approach?

Extremely Likely			Might/ Might Not			Not at all Likely	Not Sure
7	6	5	4	3	2	1	0

c. Given the cost to the college/university for this approach, how would you rate its value to the college/university?

Great Value			Average Value			Poor Value	Not Sure
7	6	5	4	3	2	1	0

Total Quality Education:

Faculty would attend 2-3 day on campus Total Quality courses (typically 25 participants per course) that are patterned after those that businesses normally provide to their employees. There would be some minor modifications for the academic participants to make the experience more relevant. The education would be provided directly by companies, professional associations, or consultants that normally provide Total Quality education to business.

Cost to the College/University: $0-$6,500 per course

Cost to Industry: Development costs.

a. How effective do you believe the above approach would be in developing your business school faculty's interest and skills to teach TQ?

Extremely Effective			Average Effectiveness			Not at all Effective	Not Sure
7	6	5	4	3	2	1	0

b. How likely do you feel your faculty would be to attend/participate in the above approach?

Extremely Likely			Might/ Might Not			Not at all Likely	Not Sure
7	6	5	4	3	2	1	0

c. Given the cost to the college/university for this approach, how would you rate its value to the college/university?

Great Value			Average Value			Poor Value	Not Sure
7	6	5	4	3	2	1	0

Total Quality Workshops:

Workshops sponsored by academic accreditation organizations (AACSB & ABET) which focus on issues like strategic planning; processes to improve faculty performance (classroom instruction, advising, research, etc...); approaches to measuring performance; emerging curriculum topics; changing the faculty reward structure; quality indicators and benchmarks; strategies for developing teamwork and communication skills in students; etc..

Cost to the College/University: Travel and lodging expenses plus a $300-$500 conference fee.

Cost to Industry: None

a. How effective do you believe the above approach would be in developing your business school faculty's interest and skills to teach TQ?

Extremely Effective			Average Effectiveness			Not at all Effective	Not Sure
7	6	5	4	3	2	1	0

b. How likely do you feel your faculty would be to attend/participate in the above approach?

Extremely Likely			Might/ Might Not			Not at all Likely	Not Sure
7	6	5	4	3	2	1	0

c. Given the cost to the college/university for this approach, how would you rate its value to the college/university?

Great Value			Average Value			Poor Value	Not Sure
7	6	5	4	3	2	1	0

Resource Guide:

A guide which includes class outlines and materials, reading and teaching notes that represent "the best of" alternate approaches being used at a cross section of schools. A respected faculty member would serve as editor of the guide, responsible for collecting, selecting and editing items to be included.

Cost to the College/University: $20-$40 per guide

Cost to Industry: None

a. How effective do you believe the above approach would be in developing your business school faculty's interest and skills to teach TQ?

Extremely Effective			Average Effectiveness			Not at all Effective	Not Sure
7	6	5	4	3	2	1	0

b. How likely do you feel your faculty would be to attend/participate in the above approach?

Extremely Likely			Might/ Might Not			Not at all Likely	Not Sure
7	6	5	4	3	2	1	0

c. Given the cost to the college/university for this approach, how would you rate its value to the college/university?

Great Value			Average Value			Poor Value	Not Sure
7	6	5	4	3	2	1	0

In the space below, please describe any other approaches that you feel would be better ways to prepare faculty members to teach TQ principles and methods.

_____

_____

_____

_____

Which of the following statements best describes the *status of integrating* Total Quality into your business school undergraduate and graduate curricula?

	Undergraduate School	Graduate School
The business school is not currently including Total Quality principles and methods in the curricula and has not developed plans to do so	❑ 1	❑ 1
The business school is planning to include Total Quality as part of the curricula but has not yet implemented these plans	❑ 2	❑ 2
Total Quality principles and methods are well integrated into a few (1-5) courses in our business school	❑ 3	❑ 3
Total Quality principles and methods are well integrated into many (6 or more) of the courses in our business school	❑ 4	❑ 4
Not applicable		❑ 5

Which of the following statements best describes the *status of practicing* Total Quality across the entire college/university? (Please check as many as apply.)

❑ 1 Total Quality is not being practiced.
❑ 2 We are beginning to practice Total Quality in administrative areas.
❑ 3 Our practice of Total Quality in administrative areas is fairly advanced.
❑ 4 We are beginning to practice Total Quality in "academic areas" (curricula, research, etc...).
❑ 5 Our practice of Total Quality in "academic areas" is fairly advanced.

Within the past year, approximately what percent of the business school's research dollars have been spent on researching TQ? _____%

Do you feel that faculty from the business and engineering schools at your college/university should jointly participate in the same faculty development process to learn about TQ, or not?

❑ 1 Yes
❑ 2 No
❑ 3 Don't have both business and engineering schools

Finally, within your business school, approximately how many students are there in the:

Undergraduate Program _____

Graduate Program _____

Thank you very much for your willingness to participate in this survey. Please return your completed questionnaire in the enclosed postage paid envelope.

Total Quality Research Working Council

Working Council Membership

Co-Chairs

Mark P. Finster
Professor, Grainger School of Business, University of Wisconsin - Madison

Stephen B. Schwartz
Senior Vice President, Market-Driven Quality, IBM

Members

Robert Cole
Professor, Haas School of Business, University of California - Berkeley

Stephen L. Graves
Deputy Dean, Sloan School of Management, Massachusetts Institute of Technology

Robert King
Executive Director, GOAL/QPC

Peter J. Kolesar
Professor, Graduate School of Business, Columbia University

Mary Kowalski
Senior Partner, 3M

Lucy Morse
National Science Foundation

Howard D. Wilson
Director, Market-Driven Quality, IBM

Contents

Executive Summary
1. Introduction: Purpose, Customers and Benefits
2. Study Methodology
3. Summary of Findings
4. Recommendations
5. Current Research and Future Research Directions
    - Industry Research Needs
    - Human Resource Management
    - Customer-Supplier Relationships
    - Strategic Planning
    - Marketing
    - Statistical Methods
    - Operations Management
    - Finance/Accounting
    - Engineering
    - Cross-Functional Management
    - Baldrige Award Criteria
    - Other Contributing Groups
        - ➢ University of Wisconsin Center for Quality and Productivity Improvement
        - ➢ Deming User Groups
        - ➢ GOAL/QPC
        - ➢ Juran Institute
        - ➢ Joiner Associates
        - ➢ American Productivity and Quality Center
    - Japan
6. Annotated Bibliography

Total Quality Research Working Council

Executive Summary

Study Methodology

Council members investigated global research activities, completed and underway, in journals, centers of competence, foundations, consulting groups, study groups, government, industry and academia. Topics were investigated from both a functional and cross-functional perspective. Examination included: human resource management, customer/supplier relationships, strategic planning, marketing, statistics, operations management, finance/accounting, engineering, process management, cross-functional management, and the seven categories of the Malcolm Baldrige Award criteria. The council's collective findings led to the development of recommendations to enhance Total Quality research.

Key Findings

Total Quality (TQ) research has been and continues to be conducted in most of the key areas the council investigated (abstracts and annotated references are included in Section 6). Based on the council's findings, research currently underway and completed is important and necessary, but it is not sufficient for the task of complete understanding and implementation of a "Total Quality Management System." Additional research is needed in theoretical, empirical and operational areas in TQ. From empirical studies that extract key accelerators of TQ practice, to functional and cross-functional issues, there are numerous opportunities for research that strengthen the thinking and accelerate the practice of TQ. Details are provided in Sections 3 and 5. Barriers to research in TQ were identified by examining the funding and research processes. Key barriers relate to the lack of "customer-focused" research, shortage of funding for TQ, the

functional nature of universities and research publications, insufficient publishing sources, and lack of recognition for the importance of research in TQ.

Key Recommendations

1. Strengthen customer-focused research by connecting researchers to their customers.

   Actions:

   - ***Establish new academic/industry research partnerships.***
     By "industry" we mean the profit and nonprofit, private and public sectors. Partnership arrangements may be patterned after successful domestic and international models (model examples are included in Section 4). The partnerships may include but are not limited to: grants, loaned executives, internships, Total Quality education/training, cooperative research, consortiums/networks and specific focus programs/efforts.
   - ***Expand existing partnerships between industry and academia to include research in TQ.***
     There are many Industry/Academic or Government/Academic partnerships currently in place. Without changing the structure of the partnership, add Total Quality as a necessary research component of these efforts.
   - ***During all stages of research, identify important customer needs.***
     During all stages of research, including formulation of the research proposal, peer review, funding evaluation, conducting the research, and publication, important customers and their priority needs that are addressed by the research can be formally identified.

2. Increase research in TQ.

   Actions:

   - ***Broaden the funding agendas for major funding agencies so that they include TQ.***
     The Leadership Steering Committee should influence heads of key funding organizations (e.g., DOD, NSF, ONR, Sloan) that support academic studies of industry, to include Total Quality research as a prominent, publicly visible criterion for funding decisions.

- ***Develop a new "Funding Pool" for ongoing research in TQ.***
  A research grant mechanism similar to the grant programs run by the National Science Foundation, the National Institute of Health, the Office of Naval Research, etc. is recommended. This recommendation requires installation of a pool of funds and general guidelines framing the domain of research to be supported. Detailed proposals would be submitted by academics and reviewed by a joint panel of university and industry experts. The best proposals would be funded. A five-year commitment to this program at a funding level of $20M, sourced through the leadership committee, is recommended.
- ***Establish research journal awards to recognize outstanding research in TQ.***
  The Leadership Steering Committee should coordinate and establish financial awards for best published articles in quality in major research journals. Funding for these awards would be provided from the $20M "Funding Pool."
- ***Establish unrestricted distinguished research fellowships in TQ.***
  Establish distinguished faculty research fellowships in Total Quality. The recipients would be the most distinguished of university researchers, who would commit to a year of unconstrained research and inquiry in Total Quality. Recipients would be selected by a joint university/industry panel. The university would commit to paying half salary and fringe benefits. Additional funding of $100,000 would be provided from the "Funding Pool."
- ***Establish a research agenda in TQ.***
  Continue the seminal work done by this committee. Rigorously identify a research agenda for TQ. Include input from industry and from Baldrige judges and examiners. Broaden the research categories identified by this committee and strengthen analysis from the perspective of the Baldrige criteria.
- ***Generate and support cross-functional research.***
  Much research in TQ requires a systemic cross-functional approach rather than optimization of a functional area. To generate cross-functional research in TQ, agencies need to fund such research, journals need to

publish such research, and universities need to provide the organizational structure and influence reward structures in business and engineering schools to support such research.

- *Influence the reward structure in business and engineering schools.* TQM research is likely to require extensive field work, involve multiple functions/disciplines, and require substantial collaboration both with industry and other colleagues. The current review and reward processes for faculty make TQM research a risky endeavor. To change faculty behavior requires actions to either reduce the risk associated with TQM research or increase the awards. The council recommends enhancements in the reward structure to accelerate Total Quality research.

1. Introduction: Purpose, Customers and Benefits

Council Purpose

The primary purpose of the research council was to globally examine current research in TQ and identify key research directions that would develop the thinking and accelerate the practice of Total Quality. Recommendations for stimulating the needed research were also formulated.

What is Research?

The council realized that the word "research" has various meanings and is not used the same in industry as in academia. Since this report will be read by representatives of both sectors, we clarify some of these differences below.

Characteristics of Research in TQ

Academia	Industry
Theory and its creation	Practice and "how to"
Empirical evidence	Identifying attributes that accelerate practice
Before, during and after data	Comparative analysis
Successes and failures	Identifying the geography of TQ
Publishable	

Who Are Our Customers?

The council identified key customers for our research council as well as key customers for the research process.

Customers for the Research Council

- Researchers in academia, particularly those in business and engineering schools, including students writing master's and Ph.D. theses
- The leadership committee who will stimulate action toward the realization of our recommendations
- Key movers and shakers such as deans, provosts and journal editors

Customers for the Research Process

- Curriculum developers who will use research results to develop new curriculum
- Industry, public and nonprofit organizations who will use research results to accelerate the thinking and practice of TQ
- Society at large who will benefit from the accelerated practice of TQ

Benefits of Research in TQ

There are many benefits to funding substantial research in TQ. If America's top researchers focus their main attention on TQ, they will be able to point the way to accelerate the practice of TQ. The expanded faculty interest and expertise in TQ will also lead to rapid changes in curricula. Future company employees (university graduates) will then be trained at the cutting edge, bringing in new and advanced skills and practices in TQ, not just core competencies. Ph.D. candidates will be researching TQ under the guidance of current faculty and hence, future faculty will also have a dominant focus on TQ.

2. Study Methodology

After defining research and identifying our customers, we began to inventory and synthesize global TQ research activity, and identify industry's needs for additional TQ research. This information, and the individual expertise of the council members, formed the basis for our descriptions of key research directions. By examining the research process, including funding and publishing, we identified barriers to research in TQ and then developed recommendations that would accelerate this research.

Toward that aim we investigated global research and activities completed and underway in journals, publications, foundations, centers, consulting groups, study groups, and industry in both this country and overseas. Topics investigated and used to generate research directions included human resource management, customer-supplier relationships, strategic planning, marketing, statistics, operations management, finance, accounting, engineering, cross-functional management and process management. We also used the Baldrige categories as a basis to generate research opportunities.

Although these topics were identified as critical to schools of business and colleges of engineering, our search for research topics was not comprehensive. For example, important areas like psychology (e.g., motivation), anthropology (e.g., culture change), education and health care were not rigorously investigated. It is not the council's intention to characterize areas omitted as areas of lesser importance in TQ. They were not investigated because of constraints on resources available to the council.

The research directions identified were intended to earmark important areas of research in TQ. They were also to act as linkage to important academic research underway but not currently under the TQ umbrella.

The council membership was dominated by individuals whose areas of expertise are traditionally found in schools of business and industrial engineering. The research directions identified reflect that membership; and, tend to focus more on the management side of TQ. However, our findings are not a statement of the relative importance of engineering and business to TQ. A council with greater engineering representation would probably have focused more on engineering issues.

Industry's research needs were not thoroughly investigated. In Section 5 we provide a description of the industry needs identified by senior representatives from sponsor companies of the Total Quality Forum. Our recommendations address methods by which researchers can better understand the needs of their organizational customers.

A summary of our findings is given in the next section. Recommendations for accelerating research are described in Section 4 and a detailed description of key research directions is provided in Section 5.

3. Summary of Findings

Current Research and Research Directions

Our global search for research in TQ revealed that many articles related to TQ have been written. One library data source lists over 17,000 articles published in English with quality as a key word. There are at least two books (see Appendix: Krismann, 1988; GOAL/QPC, 1992) that consist of extensive annotated bibliographies on quality. There are also several publications that regularly include articles related to TQ. Hence, anyone looking for publications in TQ will have little difficulty finding numerous materials that address the subject.

Examples of Major Research Related to TQ

Topic	Some Major Researchers
Design of Experiments	Box, Taguchi
Service Quality	Zeithaml, Parasuraman and Berry
Quality Function Deployment	Akao
Policy Deployment	Akao
Competitive Strategy	Porter
Organizational Learning	Senge

When searching traditional academic areas and journals, we found much variation in the number of published articles relating to quality issues. Some academic areas (e.g., marketing) publish a variety of articles relating to quality while other academic areas (e.g., finance) publish none. There is also much research being done that relates to quality but is not under the TQ umbrella.

However, most of the articles published on quality were practitioner-oriented. Many were anecdotal or prescriptive in nature and most would be considered elementary from an academic perspective. Most would not be categorized as serious academic research. In fact, quality as a research subject is just beginning to make it into mainstream academic journals and the focus of most of these publications is very much practitioner-oriented. Within an academic discipline, the more theory-oriented or empirically-rigorous the journal, the less likely quality appears as a theme. The bottom line on academic research is that highly

rated academic journals tend to publish few articles relating directly to TQ. In other words, TQ is not a major subject of academic research.

However, our findings uncovered a great need and many opportunities for theoretical, empirical and operational research in TQ. These findings and future research directions are described in detail in Section 6. Here we give a few brief examples that provide a flavor of the numerous research opportunities available and useful for developing the thinking and accelerating the practice of TQ.

Examples of research questions and issues in Total Quality:

- Does pay-for-performance support a TQ system?
- If not control, what is the fundamental role of accounting and finance in an empowered customer-driven process-oriented organization?
- How does an organization establish an information network of customer-driven process-based financial and non-financial performance measures that provide information to assist people in controlling and improving processes, and in making business decisions.
- What are new and better methods, techniques and processes for identifying, collecting, aggregating, analyzing and prioritizing customer needs and expectations, and then communicating these needs into all areas of the organization.
- Systems, methods and tools for customer-driven deployment of quality, cost, technology and reliability for new products and services during planning, research and development, design, purchasing, production, distribution, sales and after service (e.g., quality function deployment, concurrent and kansei engineering, design of experiments).
- Philosophy, structures, methods and tools for policy and strategic breakthrough management (e.g., policy deployment and Hoshin Kanri).
- Organizational structures and definable, predictable, repeatable processes for identifying and managing horizontal functions of an organization through cross-functional management.
- Empirical studies (e.g., before, during and after) relating to benefits, successes and failures of TQ applications, and to identification of key success drivers.
- Improvement in the basic operations of every functional area (e.g., accounting, engineering, marketing) through the development of TQ

philosophy and methodology (e.g., process management) within that function.

- The thinking, organizational structures and methods involved in becoming a learning organization, including such issues as education, training, standardization, enhancing and capturing creativity, empowerment, cloning and lateral thinking, sharing conferences, etc.
- Cooperative versus competitive thinking and methodology in such areas as supplier-customer relations (e.g., Procter and Gamble and Wal-Mart), management-labor relations, cross-functional relations, direct competitor relations (e.g., IBM and Apple), and teamwork versus individuality.
- Philosophy, structure, methods and techniques that enhance system thinking and dynamics.
- Examination of the economist's pursuit of agency theory that reduces organizational life to a series of contracts and makes a number of assumptions with regard to cheating, limited information and bounded rationality as reflected in problems of "adverse selection" and "moral hazards," resulting in the need for monitoring to deal with these problems, in direct contrast to the TQ focus on employee involvement and empowerment.
- TQ in a service environment (government, university, health care, etc.) including the service areas (marketing, planning, administration, etc.) within an organization.

Barriers to Research in TQ

The council also discussed the process by which research is proposed, funded, conducted, and published. We found that effective research in TQ can be inhibited through a lack of customer focus, shortage of funding, the functional nature of research publications, insufficient publishing opportunities and scarce recognition of the importance of research in TQ.

1. Lack of customer-focused research
    - The major barrier to customer-focused research is a lack of connectivity between academic researchers and their organizational customers.
    - It is difficult for academic researchers to obtain regular feedback on their research from organizational users.

- ➢ Communication channels between "users" and "researchers" are not well developed.
- ➢ Often the practical aspects of theoretical research might occur years after the publication of the concepts.

- It is difficult for industry to clearly articulate its needs in detail.
- The "customers" of research journals do not usually include organizational users.
  - ➢ Many researchers consider only other researchers to be their primary customers.
  - ➢ This leads, in some cases, to research journals that have become disconnected from their organizational and industrial customers, sometimes resulting in "closed-loop" publishing where researchers may publish to each other solely for publication's sake.
- Leading research that accelerates TQ practice must focus ahead of industry — not just on its exhaust.

2. Shortage of funding for TQ
   - Major funding sources are not currently allocating significant resources to research in TQ.
   - Research is funded primarily through functional channels whereas much of TQ is integrative and cross-functional in nature and hence inappropriate for functional funding.
   - Most research is functional in nature and hence proposals for funding are reviewed through a peer system of functional experts unlikely to fund integrative and cross-functional work.
3. The functional nature of universities and research publications
   - Since academic journals focus on functional areas, research is segmented. Much of TQ research is integrative and cross-functional in nature and, hence, not appropriate for publication in such journals.
   - The functional nature of schools of business and engineering tends to segment research;
     - ➢ Hence the integrative and cross-functional nature of TQ research has no "home" to live and thrive in; it belongs in no single functional area.

- ➢ Cross-functional research tends not to be valued and rewarded by functional experts during periods of evaluation and reward.
- Functional domains tend not to fund cross-functional research.
- Since faculty grow up and become experts in functional institutions, it is difficult to understand fully the systemic cross-functional nature of TQ.
  - ➢ There is a tendency for academicians to believe that they know TQ since for each piece of TQ there seems to be some faculty member who understands it.
  - ➢ There are no faculty with degrees in TQ.
  - ➢ Switching to an area like TQ that has no functional home, and that requires a period of retooling to develop proficiency, has great perceived risks and short-term disadvantages.

4. Insufficient publishing opportunities
   - Currently there is only one academic journal in Total Quality that publishes in English.
     - ➢ Functional journals tend not to publish cross-functional and integrative research.
     - ➢ Leading journals do not tend to publish applied research.
     - ➢ Applied research is not valued as much as theoretical research in academic circles.
5. Scarce recognition of the importance of research in TQ
   - Since TQ is a new paradigm, it is not valued from the perspective of the old paradigm.
   - Cross-functional integrative research is considered as less important.
   - Industry practice of TQ is, for the most part, quite immature and so academia does not fully appreciate the power of TQ. Many see only part of the elephant. Many see it as a fad.

4. Recommendations

The following recommendations address the barriers to research in TQ and are intended to accelerate useful research in TQ by the university community. The actions summarized under the recommendations are described in greater detail on the following pages.

Summary of Primary Recommendations

1. Strengthen the customer-focused nature of research by connecting university researchers to their profit and nonprofit industry customers.
   Actions:
   - Establish new academic/industry research partnerships.
   - Expand existing partnerships between industry and academia to include research in TQ.
   - During all stages of the research process, researchers and funders should identify important customers and their key priority needs that will be addressed.
2. Dramatically increase the quality and amount of research in TQ.
   Actions:
   - Broaden the funding agendas for major funding agencies so that they include TQ.
   - Develop new funding pools for ongoing research in TQ.
   - Establish research journal awards to recognize outstanding research in TQ.
   - Establish unrestricted distinguished research fellowships in TQ.
   - Establish a research agenda in TQ.
   - Generate and support cross-functional research.
   - Influence the reward structure in business and engineering schools.

Recommendations and Detailed Actions

1. Strengthen the customer-focused nature of research by connecting university researchers to their profit and nonprofit industry customers.
   Actions:
   - ***Establish new academic/industry research partnerships.***
     Such partnerships may be patterned after a variety of successful domestic and international models and may include a variety of different activities including consortia, research internships for both faculty and students in both small and large companies, access to people and practices in large companies, and multi-site groups and locations for research. Examples of successful research partnership models include the MIT Leaders for Manufacturing Program, the Engineering Research Centers Program of the National Science Foundation and the IBM TQM Competition for

Colleges and Universities. Details of successful research partnership models are provided at the end of this section.

- ***Expand existing partnerships between industry and academia to include research in TQ.***

  There are many Industry/Academic and Government/Academic partnerships currently in place. Without dramatic changes in the structure of the partnership, add Total Quality as a necessary research component of these efforts.

- ***During all stages of the research process, researchers and funders should identify important customers and their key priority needs that will be addressed.***

  During formulation of the research, potential customers and their priority needs that will be addressed can be formally identified. The need for the research can then be verified from the customer's perspective by connecting with the key customers. Note that it is not sufficient to simply ask customers as research frequently goes beyond stated needs and expectations.

  During the peer review, evaluation and funding of research, the impact of the research can be formally examined from the perspective of the breadth of the impact on the customer and the depth of the impact on the key needs articulated. The number of customers affected and the impact on their key needs should be high priority criteria for funding. Impact can be evaluated from a fit-for-use perspective. To assure a customer focus and fit-for-use, we recommend that review boards for TQ research have customer representatives; i.e., members from the appropriate industry communities.

  During the research process, the researchers can work closely with their customers in verifying the direction that the research takes and in clarifying applications. During the research process, research should be conducted to guarantee fitness for use.

  When research results are published, the customers and their critical needs (that will be addressed) can be formally stated. This will document and expand the knowledge of customer needs by the university

community and will help link the research to application. The article should be written from a fit-for-use perspective.

2. Dramatically increase the quality and amount of research in TQ.

   Actions:

   The first few actions recommended address the lack of funding for research in TQ. Unless research in TQ is funded, little will be conducted. There are many benefits to funding substantial research in TQ. If America's top researchers focus their main attention on TQ, they will be able to point the way to accelerate the practice of TQ. Faculty interest and expertise in TQ will also lead to rapid improvement in curricula. Future company employees (university graduates) will then be at the cutting edge, bringing in new and advanced skills and practices in TQ, not just core competencies. Ph.D. candidates will be researching TQ under the guidance of current faculty and hence, future faculty will also have a dominant focus on TQ.

   - ***Broaden the funding agendas for major funding agencies so that they include TQ.***

     Academic and business leaders should contact the leadership of the major funding organizations that current support academic studies of industry (e.g., DOD, ONR, NSF-engineering and social science directorates, Sloan, etc.) and promote the addition of TQ to their funding agendas. Specifically, we recommend that a delegation of leadership council members (not their surrogates) meet with heads of the appropriate key funding organizations and make the case that research on quality become a prominent publicly visible criterion for funding decisions.

   - ***Develop new funding pools for ongoing research in TQ.***

     Specifically, the leadership committee should develop funding for a $20 million research pool that will support research in TQ for a period of five years. The first two years should support substantive three-year grants of $250,000 that include summer support and project assistants. The total amount funded will increase one million dollars each year from $2 million in 1993 to $6 million in 1997. The administration of the research fund is described in greater detail at the end of this section. One key aspect of administration is that industry be well represented on the review panels.

- *Establish research journal awards to recognize outstanding research in TQ.*

  Specifically, the Leadership Council should establish a method for financial/recognition awards for best published articles on quality in major research journals. For a cost of $26,000 (for awards and for marketing the awards), it is possible to award the best published articles on quality in any one of six journals over a two-year period beginning January 1, 1993. We propose an award of $10,000 for first prize, $5,000 for second prize and $2,500 for third prize. The two year qualifying period is to allow researchers lead time and to insure that a sufficient number of articles will be available as candidates. Similarly, the use of one award for six journals is designed to insure a sufficient population of articles and to encourage awareness across the journals. Awards should be marketed through advertising in the journals. The following list of journals and areas are meant to be suggestive: Management Science, Academy of Management Journal, Accounting Review, Journal of Marketing, Journal of Strategic Management, Journal of Finance.

- *Establish unrestricted distinguished research fellowships in TQ.*

  While the major thrust of our recommendations for the increase of funding on TQ focuses on company/university partnerships, we also recognize that truly creative work of a different sort can best be done in a freer context. For example, there are inherent limitations to one-company data samples. Much research (e.g., identifying success factors that accelerate the practice of TQ) requires a large sample of companies. Hence, we propose distinguished research fellowships in TQ. The recipients would be the most distinguished of university researchers, who would commit to a year of unconstrained research and inquiry in TQ. They would be selected by a joint university/industry panel. The university would commit in paying half salary and fringe benefits. The "funding pool" will provide an additional funding of $100,000 per year to cover remaining salary, travel, work expenses, computing and other expenses.

- *Establish a research agenda in TQ.*
  Establish a committee that continues the seminal work done by this committee. Assure that this committee has the resources to rigorously identify a research agenda in TQ. Include input from industry and from the Baldrige judges and examiners. Broaden the research categories identified by this committee and strengthen analysis from the perspective of the Baldrige criteria. Other recommended agenda items include: customer/employee retention, TQ measurements, performance evaluation, linkage between customer satisfaction and business results, linkage between employee skills and business results, barriers to TQ behavior, and software quality (defects, productivity and testing).
- *Generate and support cross-functional research.*
  Much of the research in TQ requires a systemic cross-functional approach. Hence, research that locally optimizes functional results without examining its impact on the whole is often detrimental to the whole. Examples are methods that focus myopically on increasing efficiencies, productivity or sales. To generate cross-functional research in TQ, agencies need to fund such research, journals need to publish such research, and universities need to provide the organizational structure and influence reward structures in business and engineering schools to support such research. Reward structures are described in the next recommendation.
- *Influence the reward structure in business and engineering schools.*
  In order to encourage faculty to undertake research in TQM, there needs to be some change in the university reward structure and review processes. TQM research is likely to require extensive field work, be long term in nature, be multi-disciplinary and require substantial collaboration both with industry and other academic colleagues. TQM is not an established academic field of study, and as such, there are not many role models for research on this topic area. The current review and reward processes for faculty make TQM research a risky endeavor for faculty, especially those without tenure. For instance, tenure reviews occur five to eight years after the completion of one's Ph.D. and tend to focus on the quantity and quality of one's contributions to an established field, as

evidenced by journal articles and by letters of reference from the leading academics in the chosen field. This discourages faculty from venturing into untested research domains, such as TQM, that have long lead times and that lack an accepted paradigm for conducting the research. To change faculty behavior requires some changes to either reduce the risk associated with TQM research or increase the rewards. For instance, the review processes could put more weight on the potential impact and relevance to industry of all research; one way to do this within the tenure review process would be to add some letters of reference from industry leaders to those solicited from the leading academics.

Examples of Successful Research Partnerships

MIT: Center for Quality Management

MIT and the Center for Quality Management provide an example of TQM research that can result from an academic/industry partnership. The Center for Quality Management is a consortium of companies and university affiliates, including MIT. The mission of the Center for Quality Management is to accelerate understanding and implementation of quality management concepts and methods by creating a network of like-minded organizations to share knowledge and experience. Independent of the Center, a doctoral student at MIT (Gary Burchill) developed a new approach for concept engineering. Concept engineering is a process for determining the customer's key requirements, creating a measurement strategy for assessing compliance with the requirements and developing a strong product concept which satisfies the requirements. To study the effectiveness of the new approach, the student contacted the Center for Quality Management to design and conduct a field experiment. Three companies from the Center for Quality Management have each designated four product development teams to be part of the study, where each company chose the teams to yield matched pairs. At each company, two of the four teams are trained in the new approach, whereas the other two teams act as control groups. The companies have literally opened their doors to the researchers to permit access to the team meetings and team members over the course of the product development process. Furthermore, for the sake of the research, the companies have resisted the temptation to implement immediately the new (improved) approach with all product development teams. The field research began in the

winter 1992 and should be finished by spring 1993. The expected results will be a better understanding of how to do concept engineering, some actual case studies of concept engineering, and refinements and improvements to the new approach. As a byproduct of the research, the student will prepare a handbook on concept engineering for the educational programs of the Center for Quality Management.

MIT: Leaders for Manufacturing

The Leaders for Manufacturing (LFM) Program is an educational/research partnership between thirteen major U.S. manufacturing firms (the "partner companies") and MIT's Schools of Engineering and Management. The program's overall goals are to discover and codify into teaching and into practice guiding principles that produce world-class manufacturing and manufacturing leaders. The program from its inception has adopted nontraditional approaches to graduate education, research, and university-industry collaboration with an aim at achieving results that have not been realized by more traditional methods.

The LFM research program has developed and implemented a process for matching MIT faculty to partner companies to conduct research of mutual interest and benefit. The process is as follows:

- Once a year faculty submit a two-page marketing document that introduces themselves to the companies and describes their general research interests and accomplishments.
- These marketing documents are then distributed to the partner companies for review; the companies rank the individual faculty according to their interest in working with the faculty member.
- With the company rankings as input, the research committee, with both MIT and company representatives, assigns faculty to companies; the objective is to match a faculty member to no more than one company and to give each company one or two faculty that it had rated highly. The number of assignments depends on the overall research budget for the program and not all faculty will get matched to a company.
- The implication of matching a faculty member to a partner company is that the program commits to a research award to the faculty member, provided that the faculty member and the partner company can agree on a research project of mutual interest. The program facilitates this

agreement by introducing the faculty to the key company liaisons, but it is left to the faculty to work with the company personnel to develop an acceptable research proposal. All research awards are for a predetermined standard amount, sufficient to support some of the faculty member's time, a graduate student and a fixed amount for assorted research expenses and travel.

- The process is repeated annually, with special provisions for continuing projects that have made satisfactory progress (according to both faculty and company partner).

NSF Engineering Research Centers

The Engineering Research Centers (ERC) Program of the National Science Foundation (NSF) was established in 1985. A primary objective of the program is to bring engineering and scientific disciplines together to address fundamental research issues crucial to the next generation of technological advances. A unique feature of the ERCs is that they bring an integrated engineering systems perspective to bear on engineering research. An equally important aim is to educate a new generation of engineering students in a cross-disciplinary team approach to problem solving and increasing their ability to contribute productively to industry. The program requires active and long-term involvement on the part of industry.

"A Partnership Model" — IBM TQM Competition for Colleges and Universities

Background: This effort/model recognizes the vital importance of Total Quality Management for the success of industry, education and government.

Purpose: To encourage colleges and universities, in partnership with IBM, to accomplish the following: (A) integrate TQM concepts into graduate, undergraduate and executive core courses in business and engineering programs; (B) to develop a faculty research program in TQM; and (C) to apply TQM in the operation of the institution and to propagate TQM research findings and practices to other colleges and universities.

Scope: Eight awards; each consisting of a combination of $1,000,000 in cash or $3,000,000 in IBM equipment. Each grant/award covers a five-year period.

Selected institutions have entered into a partnership arrangement with an IBM marketing and service area and/or a manufacturing and development site. The partnership may consist of one or more of the following elements: (A)

loaned IBM executive(s); (B) IBM speakers; (C) faculty and student internships at IBM; (D) classes on IBM's approach to market-driven quality; (E) cooperative research; or (F) participation in a network of TQM companies, colleges and universities to share information, research and "best practices."

A Model for Industry/Academic Partnerships

Objective: Establish a national network of research and industry councils that work on researching and implementing accelerators to the practice of TQ.

Administration: Office of the Malcolm Baldrige National Quality Award

Issue Selection: Issues to be researched will be selected by the office of the MBNQA with input from both academia and industry. Examples of issues (meant only to be suggestive) are:

- Strategic management: Hoshin Kanri/policy deployment/breakthrough improvement
- New product/service development/QFD including quality, cost, technology and reliability deployment
- How organizations learn/accelerating the learning process

Research Councils: For each issue selected, there will be two councils — one research council and one application council. The councils will work together to accelerate the practice of TQ by researching the issue, by developing and testing breakthrough practices, by implementing these new best practices and by widely publishing the findings.

Duration of Appointment: 5 to 7 years.

Selection of Council Members: The research council members will be primarily academic researchers who are recognized for their world-class knowledge on the issue to be accelerated. The application committee will consist primarily of leaders from industry who are active in the development and practice related to the issue, and who seek breakthrough by being the first to absorb the new best practice to be developed.

Funding: Research support will be provided through the office of the MBNQA, by the participating application committee organizations and by other funding agencies as appropriate.

Publication of Findings: The research findings will be published in both academic and practitioner journals.

Development: This partnership will start with a single issue which will be used to develop the process by which accelerators are identified, researched, developed, tested and implemented. New issues will be selected after the partnership process has been established.

Administration of the Funding Pool

Review Board — A review board will approve all grants. Fifty percent of the review board members will consist of industry representatives and fifty percent will consist of academic representatives.

Grant Application Avenues — There will be two avenues by which faculty can seek research support: open application and company partnerships. During the first two years, 50% of the funds ($2.5 million) will be granted through open application and 50% ($2.5 million) will be granted through company partnerships. After the first two years, resources can be allocated according to the approach that is most effective in producing research fit for use.

Open Application Approach — Under the open application approach, faculty will submit grant applications that will be reviewed by both industry and academics. Each grant application must specify both the research to be conducted and how this research will accelerate the practice of TQ. The board will then determine grant winners based on the reviewers' reports.

Company Partnership Approach — Under the company partnership approach, faculty will be matched with individual companies for both development of the research proposal and for conducting the research. Initially faculty will submit a vita and description of their research interests and record. The review board and participating companies will rank the faculty members as to desirability. Each highly ranked faculty member will then be partnered with one to three companies who will work with the faculty member in developing a research proposal.

The research proposal will describe the research to be conducted and how this research will accelerate the practice of TQ. The research proposal must then be approved by the review board. The companies involved will open themselves so that the faculty member can conduct the research. The key findings are to be published by the faculty member in both academic and applied journals.

A similar approach has been well received by both industry and academia in MIT's "Leaders for Manufacturing" program.

Administration Agency — An agency that will administer the routine application and distribution of funds will be selected from an already established granting agency. Examples of such agencies are the Sloan Foundation and the University of Wisconsin Alumni Foundation.

5. Current Research and Key Research Directions

This section summarizes current research and identifies key research directions in Total Quality. Further research agendas in TQ are referenced in the annotated bibliography in Section 6.

Our search for current research in TQ involved examination from both functional and cross-functional perspectives. Resource constraints limited our functional search to human resource management, customer-supplier relations, strategic planning, marketing, engineering, statistical methods, operations management, finance, accounting and engineering. A cross-functional perspective was obtained from the Baldrige criteria, cross-functional management and process management.

In addition to the above mentioned categories, current research is summarized for other contributing organizations, such as the University of Wisconsin's Center for Quality and Productivity Improvement, Deming User Groups, GOAL/QPC, Juran Institute, Joiner Associates and the American Productivity and Quality Center. We realize that there are many more contributing groups, but resource constraints limited our search to these.

Finally, we searched through the last eighteen months of three leading research journals in Japan. A content analysis was conducted and their key research directions were extracted. Summaries are provided.

The following pages provide a detailed look at our findings.

Industry Research Needs

Industries' needs were identified by a separate working council and we did not replicate their work. It would have been desirable for the findings of that council to be available to us as input. Since that was not possible, we did gather examples of industry research needs from the previous Total Quality Forum output, and from a short survey of key executives of the sponsoring companies. We share their responses here.

Assumed Employer Needs

- Robust methods
- New work and organization models
- Coaching/mentoring/facilitating
- Communication skills
  - ➢ Listening
  - ➢ Presentation
- Systems thinking

Employers' Needs from University Challenge Materials

- Strategic issue/integration
- Technical
  - ➢ Statistical tools
  - ➢ Data collection, display, analysis
  - ➢ Concurrent engineering
- Customer focus
- Leadership
- Quality improvement process/management
- Employee involvement
- Problem-solving techniques
- Cross-functional management
- Teams
- Why quality is important (company/national)
- Continuous improvement/breakthrough change
- Customer focus

Industry Research Agenda Inputs
(Leadership Steering Committee Industry Membership)

- American Express — Joseph W. Keilty, Executive V.P.
  1. Retention — the need for well researched and documented information relating measures of customer satisfaction and employee satisfaction to retention. Specifically, the retention of employees and the retention of customers. The hypothesis I would like to garner more accurate information about is that employee retention leads to customer retention

and, therefore, to increased profitability. I'd really like to know which variables under employee and customer satisfaction are the keys.

2. Measures — what techniques/systems can be used to accurately measure quality performance in a service company?
3. Performance evaluation — as team work is a key tenet of total quality management, what companies have used peer review by team members to evaluate performance? How does such a system work? What results can they demonstrate in terms of increased output or profits?

- Xerox — John E. Kelsch
  1. One area of interest is some conclusive research which links improved customer satisfaction and increased business results, particularly on customers' decision to purchase, thus linked to increased market share. This implies some understanding of what are the key factors in customer satisfaction that impact the decision.
  2. A second area of interest in the sales side of our business would be some research on understanding how to match how well customer needs can be met by the product offerings which will result in a sale. Put another way, how can sales people quickly understand whether the customer is a likely prospect for the offering, or whether there is not a good match and should direct the sales effort elsewhere? This could have a very favorable impact on sales productivity.
  3. A third area is the linkage between internal performance results (e.g., Manufacturing/product) and improved customer satisfaction. I might also describe this in the context of "must have" quality and "attractive" quality — what improvements are needed to eliminate dissatisfaction vs. those which might provide a competitive advantage. In this case, we are not focused on new product features, but effectiveness in delivery performance of design intent — both manufacturing performance and engineering changes.
  4. A fourth is an understanding of the level of competence of first line workers in using quality tools that will produce important improvements in results. This would enable prioritizing team efforts to produce more significant bottom line results.

5. Another broad area of interest is the changing of human behavior and the role of training in helping that happen. I would like to see some research at the senior executive level to determine what the true barriers are and how they might be overcome. This would include both the role of training in making that happen, and also the content/methods that should be used. We already know the value of "just-in-time" training for middle managers and professionals, but how does this relate to senior executives?

- Motorola Inc. — Richard C. Buetow, Senior Vice President
  From our perspective, the greatest need in TQ research is in the software arena. World-class software (quality) today is totally inadequate for today, tomorrow and the long-term future. The areas should address:
  - ➢ Defects
  - ➢ Productivity
  - ➢ Testing

Research Topics in Human Resource Management

Robert E. Cole and Roblyn Simeon
University of California, Berkeley
Haas School of Business

The quality of human resource management (HRM) is a central element in achieving continuous quality improvement. The human resource department has responsibility for a variety of processes that directly influence the probability of success of the quality improvement initiative. The following research questions outlined attempt to capture key issues:

Improving Quality of Human Resource Management:

- Quality of Servicing Internal Customers: Joint design of administrative systems with internal customers
- Quality of process of selection, training, performance appraisal and reward systems
- Quality of process of promotion and career development systems
- Quality of labor-management relations
- Quality of communication process (quality as common language)

General Research Themes Relating to Quality and HRM:

- Impact of quality on organizational effectiveness
- Quality theme as a motivational factor for employees
- Quality of work life to enhance productivity
- Quality campaigns as energizing force for organizations
- Quality of work design and redesign
- Quality focus as a key element of corporate culture
- Quality of inter-organizational relations and network effectiveness
- Empowerment and self-managing teams as key to higher quality
- Administrative & top executive commitment to quality
- Extent to which quality focus allows firms to realize traditional human resource management themes
- Organizational learning and the quality movement

Observations:

The quality movement provides an opportunity for firms to actualize many of the traditional themes in HRM such as employee involvement and the need for greater individual training. This should be of interest to a great many HRM researchers. Yet, as one examines the list of articles and books cited, one can not help observe that most of the literature on quality and HRM is in more popular journals and books with relatively little appearing in high prestige scholarly journals. While we are starting to see an appearance of quality-focused articles in standard HRM journals, there is almost nothing in the more theoretically-focused journals or in journals with high standards for reporting empirical research.

To remedy this situation requires that we find ways to link up the quality movement and HRM with existing scholarly analytic concerns. We believe such linkages can be identified as research themes in ways that would be of interest to a broad academic audience. Most notably, we suggest that the economist's pursuit of agency theory should be examined in the light of the implications of institutionalizing continuous quality improvement. Agency theory reduces organizational life to a series of contracts and makes a number of assumptions with regard to cheating, limited information and bounded rationality as reflected in problems of "adverse selection" and "moral hazards." The resultant need for monitoring to deal with these problems strongly goes against the traditional HRM focus on employee involvement and empowerment as well as the quality

movement with its strong emphasis on employee involvement. The quality movement brings these issues into especially sharp focus (in its simplest form: does an organization rely on self-inspection versus external inspection?).

Another way to profitably tie quality into existing scholarly concerns would be to take the increasing focus on strategic HRM and explore its integration with the quality movement. Still another approach would be to link the scholarly literature on organizational learning (as distinct from individual learning) to the quality movement. Such issues can and should be a focus of scholarly research.

Articles that describe current research in TQ and human resource management are listed and annotated in Section 6 of this report.

Research Topics in Customer-Supplier Relationships

Robert E. Cole
University of California, Berkeley
Rajan Kamath
University of Cincinnati

A central theme in the quality movement concerns the nature of customer-supplier relationships and the impact of these relationships on product and service quality. This section attempts to identify some of the major themes for future research in the area of customer-supplier relations and their impact on quality. There is a reasonably transparent linkage of quality and customer-supplier relationships to issues of current analytic interest to scholars. It is a linkage that is already being explored by a number of scholars. The following topics attempt to capture key issues for future research:

1. The market failures framework proposed by Williamson can be extended beyond explaining the make-buy decision. For example, if we consider long-term, cooperative relationships as an alternative to in-house manufacture of products or services (vertical integration). Asanuma (1989) suggests that there are specific supplier skills that are more likely to lead to a long-term relationship. Interestingly, most of these skills involve learning and technology investments that would improve quality.

   In particular, we need to know how assumptions of "bounded rationality" "uncertainty" "opportunism" and the "small numbers exchange relations" can be managed with independent suppliers. Transaction cost analysis (Williamson 1975; Walker and Weber, 1984) sees these problems as ones that

can be best dealt with by internal organization rather than independent suppliers. The Japanese model suggests otherwise (Smitka, 1991). It would appear we underestimate the problems that arise with internal organization and overestimate the intractability of managing independent suppliers. Network analysis may allow us to conceptualize innovative approaches to managing these relationships in a way that sidesteps both internal organization and independent supplier models. The contributions of customer-supplier ties to network theory, particularly in the sociological tradition, can be seen in the work of Lincoln, Gerlach and Takahashi (1992). We need much more research in this area. Such research has a potential to redefine current theory.

2. Customer-supplier relations influence the supplier's role in product development. New product development is now a major theme in business research especially in the manufacturing sector (Clark and Fujimoto, 1991). Whereas a lot of research on "concurrent engineering" has highlighted the need to remove the barriers between the functional areas of the firm (example, Design for Manufacturability focuses on tearing down the walls between manufacturing and engineering) very little is known about integrating the supplier in the product development process (Kamath and Liker, 1991). If we consider the fact that 60-70% of the value-added in the U.S. manufacturing sector is accounted for by purchased parts (recent Census of Manufacturers) it becomes clear that we need to remove the barriers that prevent the supplier from contributing to product development. Additionally, there is reason to believe that a major proportion of the quality defects that are detected in quality control efforts could have been avoided if the supplier were involved at the design stage. A cursory glance at the Japanese literature on concurrent engineering tells one that they figured this out some time ago! We need to explore the conditions under which integrating suppliers into product development improves the quality of the product development process.
3. If we view quality improvement as a process of organizational learning, we can identify routines or "standard operating procedures" in the purchasing function that are positive or negative in terms of their impact on learning. Whereas the standard approach to managing the value-added chain (see

Porter, 1985) draws attention to the strategic issues from the perspective of competition (e.g., use leverage, economies of scale, etc.), little is known about the implications of these practices for organizational learning. For example, do these routines support/harm the accumulation of knowledge about critical technologies that are out sourced? Part of the organizational learning issues involves the diffusion of the Japanese model of customer-supplier relationships especially from the manufacturing sector to American industry. There is evidence that such learning is taking place (Cusumano and Takeishi, 1991; Helper, 1991). We need more research in these areas, both descriptive and analytic.

Citations and references that describe current research in TQ are listed and annotated in Section 6 of this report.

Research Topics in Strategic Planning

Mark P. Finster
University of Wisconsin-Madison
Grainger School of Business

Strategic planning for breakthrough improvement is a major component in a Total Quality system. The two dominant schools of research in strategic planning — content and process — are not well integrated. Total Quality can act as the common language that strengthens strategic planning by bringing together these schools so that they better support each other and breakthrough improvement. Content research like formulation, firm behavior, industry studies, strategic groups within industries, large data-base studies, etc.; and, process research like implementation, culture change, control, coalition building, power and politics, performance, motivation, design, etc. raise important research questions when interfaced with TQ methodology and philosophy like customer focus, continuous improvement, data-based decision making, etc.

Opportunities for research exist in both content and process. The following topics attempt to identify some of these research opportunities.

Research Directions in Strategic Planning Related to Total Quality

- Hoshin Kanri / Policy Deployment / Hoshin Planning: What and How?
  - ➢ Comparison of the relative success of U.S. companies using Hoshin Kanri with their Japanese counterparts and an analysis/identification of the critical factors making a difference

  - ➢ Analysis of differences arising out of use of Hoshin processes with simple tools (seven QC tools) and more advanced tools (seven planning tools) such as the target-means matrix, flag chart and Toyota Q.C.D. matrices
  - ➢ Determination of differences in implementing Hoshin in small, medium and large organizations
  - ➢ Comparison of the different relationships between strategic planning and Hoshin in various industries and the strength of tying that to the relative length of product life cycle
- Use of TQ philosophy and methods to improve the strategic planning process itself to level up the rate of improvement
- Portfolio management in TQ
  - ➢ Quality and customer input in portfolio management
  - ➢ Using TQ methods and philosophy to improve portfolio management
- Development and deployment of a self-supporting network of customer-focused objectives and strategies
- Critical process selection in strategic planning
- Breakthrough target setting
  - ➢ Benchmarking and target setting
- Development and deployment of the means to attain targets
- Employee involvement in strategic planning
- Top-down strategic planning in an empowered organization
- The use of Quality-in-Daily-Work teams in strategic planning
- Presidential and management reviews
  - ➢ In progress feedback
- Measurement of progress towards objectives/targets
- Measurement of progress and effectiveness of strategies/means; learning which strategies work
- Linkage between long-term plans, mid-term plans and short-term plans
- The super ordinate role of the horizontal functions (such as quality, cost, delivery, morale and safety) and their relationship with the vertical functions (such as marketing, design and production) in planning, deployment and review

- Horizontal linkages and information flow in breakthrough improvement
- Integration with the budget process
  - ➢ Quality planning as a driver of the budget process

Examples of TQ Research Topics in Strategic Planning Related to Current Research Publications

The following topics are closely related to current research articles in strategic planning. Examples of such publications are attached in the form of an annotated bibliography.

- Integration of the business plan, total management of quality and the process of performance-related appraisal and reward
- Quality-cost tradeoff issues
  - ➢ Is quality really free?
  - ➢ For example, are strategies to lower cost without paying much attention to quality poor strategies?
- The super ordinate role of quality in manufacturing strategy
  - ➢ Is this true in the U.S.?
  - ➢ Data supports this hypothesis in Europe (at least one empirical study has been done on this issue).
- Development of information systems for planning and controlling the quality of products and processes in factories, including production, development and assessment
- Increasing the rate of improvement; measuring the rate of improvement; defining and improving the improvement process
- Buyer-supplier relationships
  - ➢ Dangers of just copying the Japanese model (at least one empirical study has been done on this issue)
  - ➢ The impact on competition of single supplier relationships
- The role and relationship between flexibility (flexible automation, flexible manufacturing, etc.) and strategy
  - ➢ Creating harmony between strategy (both content and process), internal structure and internal competencies/capabilities
- What are the types of organizational structures that support TQ?
- What is the demography of leaders and top managers more apt to be successful as transformation leaders?

- Make or buy decisions in a TQ environment
  - ➢ Within the frame of a "single supplier" policy
  - ➢ Failures of over-reliance on unit costs
- Research and development as a driver in strategic thinking
- Dynamic evolution versus static optimization as the conceptual base for policy making (at least one empirical study has been done on this issue)
- Constancy of purpose
  - ➢ The impact of being driven by short-term profitability
  - ➢ The impact of tying executive performance to short-term profitability performance
  - ➢ What are the key components in the mission statement of a TQ organization?
- Key success factors in TQ organizations; differences between TQ and non TQ organizations
- Creating more involvement in strategic planning
  - ➢ Teamwork in strategic planning
  - ➢ The strategic group technique
- Capital resource allocation for strategic quality management
- Quantification of growth opportunities created by quality differentiation
- Empirical studies linking quality with market share, profitability, employee satisfaction, etc.
- Developing new measures and methods for a firm's performance
  - ➢ Traditional measures are inadequate and sometimes misleading
  - ➢ Need non-financial measures, related to strategy, varying between locations, changing over time, simple and easy to use, providing fast feedback, and intended to teach rather than to monitor
- The role of top management in breakthrough
  - ➢ How involved should top management be in breakthrough improvement planning
- The TQ approach to mergers and acquisitions; the impact of mergers and acquisitions on quality
- Culture change issues around breakthrough improvement

- Measuring the effectiveness of strategic planning and of strategies
  - ➢ Real time measures
  - ➢ Establishing a network of improvement objectives and strategies
- Customer complaints in strategic planning
  - ➢ Encouraging customers to complain

Articles that suggest key research opportunities in strategic planning and TQ are listed and annotated in Section 6 of this report.

Research Topics in Marketing

Mark P. Finster
University of Wisconsin-Madison
Grainger School of Business

Since customer satisfaction is a cornerstone of Total Quality, marketing plays a central role in the researching and development of Total Quality. Ultimately, Total Quality extends the market concept to everyone in the value chain. Hence, marketing researchers have the opportunity to expand their role in this transformation process. The following research areas described provide examples important in Total Quality. The list is not intended to be comprehensive, nor does it imply that research in this area is nonexistent. Rather, it provides a look at some key research areas.

Research Directions in Marketing Related to Total Quality

- Quality Function Deployment
  - ➢ Customer-driven Quality Deployment
  - ➢ Linguistic analysis in the voice of the customer table
  - ➢ The role of marketing in QFD
  - ➢ House of Quality construction and analysis
  - ➢ Quality deployment in service industries
  - ➢ Four step quality deployment
  - ➢ Designing comprehensive quality deployment systems
  - ➢ Customer-driven Cost Deployment; Value Analysis
  - ➢ Customer-driven Reliability Deployment
  - ➢ Customer-driven Technology Deployment

- Methods, techniques and processes for identifying, collecting, aggregating, analyzing and prioritizing customer needs and then communicating these needs into all areas of the organization

- Going beyond expected quality to create exciting quality
  - ➢ Identifying latent needs
  - ➢ Determining unspoken customer needs by identifying emotional impact of prototypes
- Transforming market research organizations to support and practice TQ in general, and QFD and Kansei engineering in specific
- Analyzing and representing customer behavior and a customer's experience in using a product or service
  - ➢ Environmental analysis
  - ➢ Use analysis
  - ➢ Gathering word information that accurately relates a customer's experience with a product or service
- Creating customer need profiles
  - ➢ Converted demanded items into demanded quality
  - ➢ Structuring customer needs
  - ➢ Measuring customer needs and expectations
- Benchmarking
- Collecting information on customer needs through customer contact people — part-time marketers
  - ➢ Sources of customer information
- Developing and improving communication channels to feedback customer information to strategic planning and to functional daily management areas
  - ➢ Translating the voice of the customer
- Linking marketing to other functions within an organization
  - ➢ Coordinating the marketing and operations functions
  - ➢ Strengthening the marketing-manufacturing interface
  - ➢ Linking quality at the customer level to quality at the operational level

- Compensation issues for sales personnel
  - ➢ Commissions, bonuses and incentive pay and their impact on the long-term well-being of the organization — a positive or negative effect?
  - ➢ The use of customer satisfaction in compensation
- The role of coupons, special sales promotions, etc. in TQ
- Applying the philosophy, methods, and tools of TQ to marketing processes to improve the quality of their products and processes for their internal and external customers
  - ➢ Process management for new product development, sales, advertising, distribution, etc.
- Kansei engineering and sensory analysis
- Service quality
  - ➢ Measuring and analyzing
- Kano's six (not three) arrow model
- Total quality creation
- Gap analysis
- The effect of quality on brand equity

Examples of TQ Research Topics in Marketing Related to Current Research Publications

The following topics are closely related to current research articles in marketing. Examples of such publications are attached in the form of an annotated bibliography.

- Measuring quality and satisfaction
  - ➢ Developing importance measures for correlated multi-attribute responses
  - ➢ Determining the importance contribution of a single quality element when satisfaction is determined by the interaction of many correlated quality elements
  - ➢ Scale issues
  - ➢ Measuring after-sales service quality
  - ➢ Is there a generic set of characteristics which can be used to measure quality? e.g., dimensions of quality studies

  - ➢ Longitudinal measures over time versus one-point responses
  - ➢ Measuring emotional responses
- Evaluating fit-for-use product performance
- Market research on why people buy a product and on how people use a product
- Quality-cost tradeoff issues
  - ➢ Is quality really free?
  - ➢ For example, are strategies to lower cost without paying attention to quality poor strategies?
- Service Quality
  - ➢ Measuring
  - ➢ Measuring and evaluating the service encounter
  - ➢ Gap analysis
  - ➢ Identifying and fulfilling customer service expectations
- The relative importance of quality and price in determining value
- The dimensions of quality (at least one empirical study has been done on this issue)
- Establishing information and communication networks for gathering and prioritizing customers' needs
- What are the key factors in determining expected quality?
- Longitudinal studies to show the effect of continuous improvement on customer perception of quality, brand equity, etc.
- Quality and market segmentation issues
- Methods for transferring demanded quality into the quality of features/results
  - ➢ Statistical based methods like correspondence analysis
- Methods and techniques for internal customer needs; capture and assessment
- Increasing the rate of improvement; measuring the rate of improvement; defining and improving the improvement process
- Buyer-supplier relationships
  - ➢ Dangers of just copying the Japanese model (at least one empirical study has been done on this issue)
  - ➢ The impact on competition of single supplier relationships

- What are the types of organizational structures that support TQ?
- What is the demography of marketing leaders and top managers more apt to be successful as transformation leaders?
- Make or buy decisions in a TQ environment
  - ➢ Within the frame of a "single supplier" policy
  - ➢ Failures of over-reliance on unit costs
- Key success factors in TQ organizations; differences TQ and non TQ organizations
- Quantification of growth opportunities created by quality differentiation
- Empirical studies linking quality with market share, profitability, etc. (at least one empirical study has been done on this issue)
- Customer complaints in strategic planning
  - ➢ Encouraging customers to complain
- Enhancing horizontal communication during product development through methods like QFD and concurrent engineering
- Enhancing quality of distribution and customer fulfillment

Observations

One extremely important area in TQ is building quality into new products and services during planning, research and development. Main areas to be researched here involve the collection and profiling of customer information and the use of this information in quality function deployment (QFD).

There is a great difference between the United States view of QFD and the Japanese view as expressed by its main developer, Yoji Akao. What we refer to as QFD is simply called "quality deployment" in Japan. Furthermore, quality deployment is much more comprehensive than the simple four-step approach used by most organizations here. Comprehensive quality deployment would also involve customer-driven breakthrough in reliability deployment, cost deployment and technology deployment. More than 100 different types of management charts can be involved and a key issue is how to develop a unique comprehensive system for an organization.

Quality function deployment goes far beyond "quality deployment" and integrates quality deployment into the quality assurance functions, integrating, for example, with cross-functional management and with the deployment of quality into daily management.

An important collection of articles describing Japanese style "quality deployment" has been translated into English as

> *Quality Function Deployment: Integrating Customer Requirements into Product Design*, edited by Yoji Akao. Productivity Press; Cambridge, MA, 1990

The reader should be warned that this is a liberal translation in which the meaning of some technical words have been changed.

Articles that suggest key research questions in marketing and TQ are listed and annotated in Section 6 of this report.

Research Topics in Statistical Methods

Peter J. Kolesar
The Deming Center for Quality Management
Graduate School of Business
Columbia University

As indicated TQM had its birth in the application of statistical methods to problems in process control and in sampling inspection. The former continues to be a dominant theme of the modern quality movement while the latter fades away as a good solution to the wrong problem.

We divide the consideration of statistical issues into four categories. Process Control, Process Capability, Experimental Design and Miscellaneous. In an earlier paper referenced (Kolesar (1991)) we observed that too much of the past 40 years of academic research holds little relevance to actual problems. This situation is changing rapidly as the following papers cited testify. There is an revitalized focus on some traditional areas such as process control and experimental design, and an opening of new areas. It is particularly refreshing to see papers that, focused on the actual problem, bring to bear a number of different statistical tools as appropriate. The most interesting of these papers defy categorization.

Section 1. Process Control: A Long Tradition of Research

Modern quality management, that is total quality management, had its intellectual and operational origins in the work of Walter Shewhart at Bell Laboratories in the late 1920s. The question Shewhart asked then "How much variation should we leave to chance? How much may a process vary and yet be

controlled?" are still being asked today, and the framework for their answers was developed in Shewhart's early work. From Shewhart's first paper in 1926 to the latest 1992 issues of our journals on process control, industrial engineering and applied statistics, there has been a steady stream of research on the topic. Extensive bibliographies and critical evaluations can be found in Gibra [1975], Montgomery [1980] and Kolesar [1991]. The textbook of Montgomery [1991] is a comprehensive treatment of theory and practice and contains an extensive bibliography.

Classic papers and sources are listed and described in Section 6 of this report under "Research Issues in Statistical Methods: Process Control — A Long Tradition of Research."

Section 2. Process Capability: An Issue of Ideology

A process is said to be in *control* if it is statistically stable in the sense proposed by Shewhart — that is, mathematically the process output is a sequence of independent, identically distributed random variables. The usual tests of this condition involve use of one or more control charts or their equivalents. A process is said to be capable if its output is consistently within the customer specifications or requirements. Modern quality management aims to achieve both — process output should be stable and within — typically well within specifications. Firms express this in several ways. Some call for "all processes to be in control and capable," others for the ratio of the distance between specifications and the process variation to be greater than some target e.g. "Cp > 1.5", still others express such a relationship in terms of the process standard deviation — "six-sigma" quality.

Until quite recently it was thought (and taught in courses and textbooks) that increasing quality or reduction of process variation always comes at a cost. As the quality increased so did these costs and an optimal quality level short of perfection should be aimed at. The experience of the last 40 years, particularly in Japan, has shown that this view to be too limited. In many cases it has been possible to achieve higher quality, reduced variation and lower cost simultaneously — at least within broad ranges.

Today, the old and false ideology — that increased quality must come at a higher cost — is being replaced by new ideologies that "quality is free" or that "six-sigma quality levels" are to be attained regardless of the underlying

economics or the characteristics of production technology, etc. Careful research might be able to clarify and rationalize the enormous gap between these two extreme positions.

A key reference is found in the bibliography.

Section 3. Experimental Design: A Renewal of Activity

During the earliest days of research on statistical quality control it was seen that using statistically designed experiments could greatly aid in identifying fundamental process and product improvements. Yet, except for chemical process industries, and for applications in R & D laboratories these tools had not been greatly used in U.S. industry until recently. Several contemporary factors are changing this situation quickly, not the least of which is the news that Japanese industry is a heavy user of these experimental design methods. The realization that fundamental quality enhancements best occur at the design stage is another driver. The ideas of G. Taguchi, a visionary and at times controversial Japanese engineer and statistician, have been an important stimulus to both implementation and research. A sampling of recent papers will give an indication of the range of problems being studied.

These papers, and other miscellaneous statistical applications, are described in the bibliography (Section 6) at the end of this report.

TQM Research Topics in Operations Management

Peter J. Kolesar
The Deming Center for Quality Management
Graduate School of Business
Columbia University

It is difficult to define total quality management (TQM) research topics in operations management (OM) satisfactorily in part because both TQM and OM are difficult to define. Some years ago what is now TQM was the more narrow field of statistical quality control and sampling inspection, and what is now OM was a mixture of old-fashioned industrial engineering and management science type modelling of production systems. Both fields have expanded, and in the expansion have come to share a great deal. The approach that follows is based on a broad view of both.

We see TQM as the range of management activities concerned with both product quality and quality and efficiency in the processes that design,

"manufacture," deliver and "service" the products — both goods and services. We are alert to the dominant TQ themes of customer orientation, scientific and data based decision making, full participation of all employees, etc. We see OM as the range of management activities focused on the production of the goods and services of the firm. The central OM activities deal with management of "daily work", but it includes elements of planning and design, procurement and human resources management. The expansion of both TQM and OM are healthy indications of a growing holistic approach to management as seen by both practitioners and researchers.

The research questions form as broad a menu as the fields themselves. Some key issues are:

1. *Process Control, Process Capability and Quality Assurance.* This traditional area needs to be re-evaluated from the viewpoint of the actual problems occurring in diverse industries, from the viewpoint of the potentials created by new automated data gathering, data transmission and data processing technologies, from the viewpoint of the escalation of quality standards to the stratosphere of "parts per million defect rates," and from the viewpoint of ever shorter product life cycles and production lot sizes.
2. *Process and Product Design.* Victory in the market goes to he who can most efficiently and effectively design the next generation of products and processes and integrate that design with production and operations — this is true in both manufacturing and services. Various elements of TQM, OM and other disciplines come together here. The current state of affairs is that these activities are more art than science and any research agenda that can light another candle in this dark chamber will make a substantial contribution. Witness all the excitement in industry over the simple heuristic procedure called Quality Function Deployment (QFD).
3. *Human Resources Issues.* A dominant theme of TQM is to engage the entire workforce in the pursuit of continuous improvement. As a separate section is devoted to HRM we will not focus on it here except to say that it should be seen not only as a distinct area but also as an integral part of operations.
4. *Procurement and Supplier Relations.* As W. E. Deming put it so clearly and forcefully in his 14 points: "Stop doing business on the basis of price alone!" The purely competitive models for supplier-customer relations appear to

teach us the price of everything and the value of nothing. But, be on the alert! As we pass from the old ideology of expressly pitting suppliers against one another in a short run zero-sum game to the nirvana of "long term supplier-customer relationships based on mutual benefit, understanding, cooperation, etc." we may be replacing one false ideology with another. How should the system work? Don't sensible models depend on many aspects of the particular context?

Abstracts of some quite recent papers are found in the bibliography in Section 6 of this report.

Research Topics in Finance and Accounting

Mark P. Finster
University of Wisconsin-Madison
Grainger School of Business

The finance and accounting functions traditionally have served as the providers of information and decision-making for managerial control. In Total Quality Management the underlining philosophical principles of these functions are refocused through emphasis on customer satisfaction and employee empowerment. As visionary accounting professor H. Thomas Johnson explains in the preface of his latest book *Relevance Regained*:

> *"To profitably satisfy its customers in the long run, a company must be run as though the customer were in charge. Impeding the revolutionary changes companies must make to be totally customer driven is management information. Specifically, the performance measures most companies use to control behavior encourage employees to subordinate customer satisfaction to accounting results. Accounting-based performance measures drive employees to manipulate processes and cajole customers in order to achieve cost and revenue targets. Inevitably this practice diminishes competitiveness and impairs long-run profitability.*
>
> *The pathway to long-run competitiveness requires companies to develop performance measures that drive employees to keep statistical control over processes that satisfy customer expectations.*

> *... Considering the demands companies must meet to compete in the global economy, I believe that accounting has no place controlling how people work in today's business enterprise. Control is the major theme of what companies practice and universities teach under the name of management accounting. Accounting information should not, I think, be used to control business operations. Accounting goals should not be used to direct and control workers or managers. Accounting information is necessary to track financial results and to plan the extent and financing of a company. But companies that control their people and processes with accounting information will not survive in the global economy."*

Areas of accounting concerned with the issues raised by Total Quality include cost management, activity cost analysis and activity based costing. Yet Professor Johnson, in chapter eight of *Relevance Regained*, warns of the failures of using such information to control processes. Accounting professor Alfred Nanni observes,

> *"the control approach which seems to be favored by the Japanese relies less on the system and more on the employee's ability to learn about the process and to make decisions about process improvement based on direct observation."*

It is not possible in this short space to reiterate all the implications for Total Quality of Professor Johnson's critique of management accounting. We strongly urge those interested in measurement and accounting issues to read his book referenced in the bibliography in Section 6. Quality advocates will be particularly interested in his idea that financial accounting systems as we know them can not help managers make operating decisions because they are inherently incapable of providing any information about customer satisfaction or process capability. Accounting systems simply report the financial consequences of actions and transcripts. They report what customers spend, but that "revenue" information can not tell you if the spending satisfies customers' wants. Accounting systems also report what companies spend, but that "cost" information says nothing about a company's capability to cultivate a shared customer-focused vision and to promote learning and flexibility.

Moreover, Johnson believes that none of the currently popular "cost management" panaceas — including activity accounting, activity-based costing, and activity-based cost management — can assist companies' Total Quality efforts. In his view, activity-based cost management tools improve the cost accounting information that companies needed to compete in the pre-Total Quality era, when business success hinged on controlling costs through scale economies and mass production. He argues that using such information to track sources of competitiveness and productivity today is tantamount to waxing the decks of the Titanic.

Research Topics in Accounting/Finance Related to Total Quality

In the literature on accounting and finance, research pertaining to Total Quality tends to fall into two general categories. One category explores the implications for accounting and finance of the need that Total Quality creates for new customer and process performance measures. This research focuses on the role for accounting and finance (presumably a diminished or at least a very different role) in companies that no longer "manage to the bottom line." The other category explores the implications for accounting and finance departments of new Total Quality approaches to managing work. The issue under discussion in this research is how to apply in accounting and finance offices the strategies for reducing lead times, eliminating waste, and improving customer satisfaction that previously have been applied in manufacturing, design, distribution and other departments. The following list provides research issues under each category.

I. The Impact of Total Quality on the Need for Accounting and Finance
   - Establishing an information network of customer-driven process-based financial and non financial performance measures that provide information to assist people in controlling and improving processes, and in making business decisions
     - ➢ Identifying appropriate customer-driven result measures for each process
       - ✦ Appropriate measures of cost in TQ
       - ✦ Measures of quality
       - ✦ Measures of customer information for both internal and external customers

- ✦ Measures of delivery (quantity and schedule)
- ✦ Measures of safety, etc.

➢ Horizontally linking customer needs to result measures for all key processes in an organization

➢ Horizontally linking result measures of linked processes across functions so that the processes and result measures work together in a system to create customer satisfaction

➢ Vertically linking result measures and process measures so that micro-level measures are in harmony with macro-level measures and all are focused on the customer

➢ Employee involvement in the development of process performance measures

➢ Cross-functional management and the classification of performance measures into horizontal functions

- The role of cost accounting in product and service design
- The role of integrated cost management in TQ
  - ➢ Cost control issues in TQ
  - ➢ Cost planning issues
  - ➢ Cost accounting issues
  - ➢ Activity based analysis
  - ➢ Activity based costing
- Process value analysis
- Target costing
- The role of accounting control in TQ
  - ➢ Statistical control versus accounting control
- Special and common cause identification
- The presentation of accounting data
  - ➢ Run chart versus single estimates
- Dynamic evolution versus static optimization as the conceptual base for finance, accounting and policy making (at least one empirical study has been done on this issue)
- Capital resource allocation for strategic quality management
- Integration of strategic planning and breakthrough improvement with the budget process

- Quality-cost tradeoff issues
  - ➢ Is quality really free?
  - ➢ Is there a place for strategies to lower cost without paying much attention to quality?
- Key success factors in TQ organizations; differences between TQ and non TQ organizations
- The impact of short-term decision making on the long-term health of an organization
- The long-term impact of decision-making based only on financial figures
- Introduction of measures of quality, reliability, performance and customer satisfaction into financial reports and statements
  - ➢ Providing useful information to investors on performance of quality, cost, profit, delivery, safety, personnel, etc.
- Quantification of growth opportunities created by quality differentiation
- Investment analysis in a dynamic environment where change is the norm
- The TQ approach to mergers and acquisitions; the impact of mergers and acquisitions on quality

II. The Impact of Total Quality on Managing the Accounting and Finance Department

- Use of TQ philosophy and methodology to improve finance and accounting processes and to make them focused on the customer
- Flexible customer-responsive accounting systems
- Developing a quality and customer-driven budget process
- Closing the books faster, or instantaneously
- Using SPC to evaluate accounting and finance processes

Examples of TQ Research Topics in Finance and Accounting Related to Current Research Publications

The following topics are closely related to current research articles in accounting and finance. Examples of such publications are attached in the form of an annotated bibliography.

- Integration of the business plan, total management of quality and the process of performance related appraisal and reward

- Development of information systems for planning and controlling the quality of products and processes in factories, including production, development and assessment
- Increasing the rate of improvement; measuring the rate of improvement; defining and improving the improvement process
- Buyer-supplier relationships
  - ➢ Dangers of just copying the Japanese model (at least one empirical study has been done on this issue)
  - ➢ The impact on competition of single supplier relationships
- Make or buy decisions in a TQ environment
  - ➢ Within the frame of a "single supplier" policy
  - ➢ Failures of over-reliance on unit costs
- Constancy of purpose
  - ➢ The impact of being driven by short-term profitability
  - ➢ The impact of tying executive performance to short-term profitability performance
- Key success factors in TQ organizations; differences between TQ and non TQ organizations
- Empirical studies linking quality with market share, profitability, employee satisfaction, etc.
- Developing new measures and methods for a firm's performance
  - ➢ Traditional measures are inadequate and sometimes misleading
  - ➢ Need non-financial measures, related to strategy, varying between locations, changing over time, simple and easy to use, providing fast feedback, and intended to teach rather than to monitor
- The role of top management in breakthrough
  - ➢ How involved should top management be in breakthrough improvement planning
- Measuring the effectiveness of strategic planning and of strategies
  - ➢ Real time measures
  - ➢ Establishing a network of improvement objectives and strategies

- Macro studies examining the relationship between the economic well-being of a country and the quality of its products and services
  - ➢ Changes in welfare due to changes in quality
- Decision making models that integrate financial and non financial measures
- How does one measure, in real time, the success and progress of an improvement project team?
- Should quality be a determinant in compensation? If so, how?
- The role of telecommunications in TQ
- Value-added management and accounting, particularly in design
- Providing financial and non-financial information feedback and feed forward to and from internal customers
  - ➢ In areas like marketing, finance and research and development
  - ➢ In areas where
    - ✦ underlying business systems are unclear
    - ✦ customer requirements are difficult to define
    - ✦ the work process is not documented
    - ✦ the performance is hard to measure

Key references and articles that suggest key research issues in finance and accounting are listed and annotated in the bibliography in Section 6.

Research Topics on TQM in Engineering

Steve Graves
Sloan School of Management
Massachusetts Institute of Technology

A central theme in total quality management is customer satisfaction. Design, manufacturing and process engineering is essential to achieving customer satisfaction in manufacturing contexts as well as many service contexts. Engineering research can contribute to our understanding of customer satisfaction and our ability to increase customer satisfaction. Nevertheless, not all engineering research can or should be relevant to TQM. Some topics and themes for research on TQM are described and organized according to four key issues.

1. *Be responsive to voice of the customer with appropriate application of technology*
   This theme focuses on identification of the customer and the customer requirements, including measurement and quantification of these requirements. Based on this, we need to understand how to select, develop and implement the appropriate product and process technology to satisfy the customer. This includes how to translate customer requirements into engineering specifications, and how to convert engineering requirements into design concepts and engineering solutions. Research is also needed to develop technologies for facilitating rapid customer evaluation and feedback on products and product prototypes; for instance, we need research to develop multi-media displays, simulations and information systems for the purpose of demonstrating products and collecting customer feedback.
2. *Minimize quality loss and maximize functionality of product and process*
   Product robustness assures that product performance and customer satisfaction do not degrade much when the product is subject to abnormal conditions, inputs or use. A similar definition applies for process robustness. Research is needed to understand how to design and manufacture robust products and how to design and operate robust processes. Subtopics for research include (i) how to set tolerances to minimize total product cost; (ii) how to optimize process controls to minimize total product cost; (iii) how to develop proactive quality management processes that anticipate problems before they occur; (iv) how to define simple, proactive measures of performance such as Taguchi's signal-to-noise improve the development of product robustness; and (v) how to prototype products and pilot production rapidly.
3. *Improve development process with emphasis on shortening time to market*
   Many phases of the development process are routinely performed suboptimally because engineers lack skills, design tools, project management tools, access to information, etc. Furthermore, these development phases are typically not well coordinated because of poor management strategies, inadequate communication, and lack of vision. Because of increasing competitiveness in all markets, such ineffectiveness is unacceptable. Research is needed to find ways to improve the performance of development teams so that time to market can be shortened and product quality improved.

Subtopics include research on (i) how to use technology such as CAD/CAM/CAE tools to improve concurrent design and engineering; (ii) how to determine the role of component or subsystem suppliers in the development process; and (iii) how to model the development process to provide insights into how to organize the process better and set priorities.

4. *Enable high-variety, high-quality, short-lead-time production*
   For most discrete-part manufacturing, the ideal is unit production, i.e., lot size of one. Another way of expressing this goal is in terms of continuous flow manufacturing with both mix and volume flexibility. The focus of this research is to understand the constraints that prohibit achieving this target and then develop mechanisms, models and technologies for progressing to this goal. This should encompass many efforts on improving operations, as well as design for manufacturing. Subtopics include research to (i) improve production planning and scheduling; (ii) improve approaches for obtaining manufacturable product designs; (iii) improve approaches for introducing new products into production; (iv) develop product technologies that enable new types of customer experiences, e.g., smart products with embedded computer controls and customizable products; and (v) develop flexible processes and understand how to evaluate flexibility.

Engineering Research Opportunities in Quality

Lucy Morse
National Science Foundation

Within engineering research the discussion of quality is more general in nature, rather than discipline specific. Some of the developments are:

- The National Science Foundation (NSF) currently has a task force on Quality in Engineering Education. The mission of this committee is to recommend a role for NSF to play.
- Two of the four NSF sponsored engineering coalitions have quality as a major component.
- The Dean's Council of the American Society for Engineering Education (ASEE) has established a subcommittee on Quality Education with John Bolinger, Dean at the University of Wisconsin, as Chair.

- The Accreditation Board for Engineering and Technology (ABET) has established a quality committee and is trying to blend the quality process with the accrediting process.
- American Association of Engineering Societies (AAES) is a member of UPADI (Union of Pan American Engineering Societies), which has established a quality committee for engineers in Latin American industries and universities.
- AAES is sponsoring a Quality conference for Central and Eastern European engineers in management and education.
- Most engineering discipline conferences and annual meetings have Quality tracks discussing research on quality in engineering.
- All engineering education conferences now have technical quality tracks.

Research Topics in Cross-Functional Management

Mark P. Finster
University of Wisconsin-Madison
Grainger School of Business

According to the TQC School, cross-functional management (CFM) involves;

> *"Activities which settle all-company goals for the basic management elements such as quality, cost, volume, and delivery, and then plans for carrying out these goals efficiently by dividing up duties among the different divisions, with cooperation and coordination occurring between divisions." JUSE*

Put another way, CFM is a definable, repeatable, predictable process for managing the *horizontal* functions of an organization. These functions are selected and managed at the highest levels of an organization. CFM does not simply consist of multifunctional process management teams represented by various vertical functions, as the term is commonly used in the United States. Every Deming Prize winner over the last 12 years has had a formal definable, repeatable, predictable system of CFM in place so that its senior management can manage its well-defined horizontal functions.

Research Topics in Cross-Functional Management

- Definition/description of CFM
- Need for CFM
- Examples and classification methods for horizontal functions
- Characteristics of horizontal functions
- Structure of CFM
- Simple structures for small organizations
- General structures for divisional and strategic business units
- Advanced system structures for large organizations
- Duties of cross-functional committees
- Operation of cross-functional committees
- Policy, cross-functional and daily management
- CFM, department management and product-based management
- Effects of CFM
- Development of CFM and four basic procedures for implementation
- Promoting CFM
- Improvement of the CFM system
- QA system charts and cross-functional management activities charts
- The role of top management
- Stages of development for TQM and the appropriate stage for development of CFM

A key reference is listed in the bibliography in Section 6.

Process Management

Howard Wilson
IBM Corporation

Process management recognizes the need for cross-functional processes designed to meet and/or exceed customers' wants and needs. The cross functional nature of process management suggests a need for high level individual ownership. Process ownership includes but is not limited to:

- defining a closed-loop process management system that is appropriately optimized.
- Defining the goals and objectives, scope and boundaries of the process, along with input/output, key dependencies, and relationships with other processes and functions.

- Ensuring the process is effective and efficient within its scope and boundaries.
- Continuous improvement and assessment of the process through benchmarking.

Research question: describe the attributes of a world-class process management system in keeping with customers' wants and needs.

For more information regarding process management education, contact IBM Skill Dynamics at 1-800-426-8322.

Research Agenda

Malcolm Baldrige National Quality Award Criteria

Howard Wilson
IBM Corporation

The national quality award initiative launched in 1987 continues to stimulate cooperation and to build awareness of the central role of quality in strengthening national competitiveness. The award criteria have been widely accepted as a barometer for continuous improvement.

To achieve these results-oriented goals, the criteria are built upon a set of values that together address and integrate overall performance requirements.

Core Values and Concepts

The criteria are built upon these core values and concepts:

- customer-driven quality
- leadership
- continuous improvement
- full participation
- fast response
- design quality and prevention
- long-range outlook
- management by fact
- partnership development
- public responsibility

Criteria Framework

The core values and concepts are embodied in seven categories, as follows:

1.0 Leadership
2.0 Information and analysis
3.0 Strategic quality planning
4.0 Human resource development and management
5.0 Management of process quality
6.0 Quality and operational results
7.0 Customer focus and satisfaction

The leadership category examines senior executives' personal leadership and involvement in creating and sustaining a customer focus and clear and visible quality values. Also examined is how the quality values are integrated into the company's management system and reflected in the manner in which the company addresses its public responsibilities.

The information and analysis category examines the scope, validity, analysis, management and use of data and information to drive quality excellence and improve competitive performance. Also examined is the adequacy of the data, information, and analysis system to support improvement of the company's customer focus, products, services and internal operations.

The strategic quality planning category examines the company's planning process and how all key quality requirements are integrated into overall business planning. Also examined are the company's short-and longer-term plans and how quality and performance requirements are deployed to all work units.

The human resource development and management category examines the key elements of how the company develops and realizes the full potential of the workforce to pursue the company's quality and performance objectives. Also examined are the company's efforts to build and maintain an environment for quality excellence conducive to full participation and personal and organizational growth.

The management of process quality category examines the systematic processes the company uses to pursue ever higher quality and company performance. Examined are the key elements of process management, including design, management of process quality for all work units and suppliers, systematic quality improvement, and quality assessment.

The quality and operational results category examines the company's quality levels and improvement trends in quality, company operational performance, and supplier quality. Also examined are current quality and performance levels relative to those of competitors.

The customer focus and satisfaction category examines the company's relationships with customers and its knowledge of customer requirements and of the key quality factors that determine marketplace competitiveness. Also examined are the company's methods to determine customer satisfaction, current trends and levels of satisfaction, and these results relative to competitors.

In addition to the items listed, the research agenda must include tools and techniques to accelerate behavior change in keeping with the Baldrige criteria.

Research Questions on Baldrige Categories

Peter J. Kolesar
The Deming Center for Quality Management
Graduate School of Business
Columbia University

Category 1. Leadership

1. What are quality values?
2. It is said that a root cause of U.S. quality problems is the drive for short-term performance.
   - Is this true?
   - What is the source of this drive?
   - How could it be changed?
3. A major element of U.S. management style is said to be "delegation", yet it is also said that quality management cannot be delegated.
   - Is this true?
   - What elements of quality management can be delegated?
   - How can one delegate yet still lead?
4. Looking at leadership from a perspective of behavior, what are the effective behaviors and tools at the disposal of the would be total quality leader? Can these be codified and learned or acquired or are they innate?
5. Comparative studies of the styles, behaviors, tools and personalities of alleged total quality leaders across different sizes of firms, different industries and different nations.

6. Are the tools and practices of TQ that were created for the operational problems of the shop floor also applicable to the executive suite and to the main business problems of the enterprise, as is claimed? Are there case examples of such implementation?
7. Is there a satisfactory way to measure commitment or leadership?
8. How do Baldrige scores on "Leadership" correlate with scores in other categories. Does the data show that leadership is in fact the driver of continuous improvement and quality performance?
9. What is the role of "communication" in establishing leadership and steering and during the quality process?
10. The following is a list of alleged problems firms experience in leading on TQ implementation. Are they real? What are their causes? What are solutions?
    - Lack of implementation of TQM tools on the key business issues — use of TQM tools limited to peripheral rather than the central problems or core work processes.
    - Quality in reality remains job number 2, separate from business planning and decision making — corporate goal setting, allocation of resources and rewards reflect this actual rather than the espoused status of quality and customer satisfaction.
    - Management not fully knowledgeable about strategy, could not and did not communicate it throughout the company — downward and across levels.
    - An attitude of top management that the quality effort and activities can be delegated.
11. What is in fact known about leadership in general or in other contexts like the military? How is it taught? What can be extrapolated to TQ?

Malcolm Baldrige Category #3

See the section on Strategic Planning.

Malcolm Baldrige Category #4

See the section on Human Resource Management.

Category 5. Quality Assurance of Products and Services

5.1 Design and Introduction of New Products

1. What are demonstrably effective ways to organize the design function, to link it to the customer and the market place and to the operations arms of the enterprise? quality values?
2. What are the organizational and environmental determinants of effective design and innovation?
3. What can be learned about the specifics of effective design (product and process) and innovation by studying Baldrige Award and Deming Prize winners?

5.2 Process Control

1. What changes in process control technology and systems are called for by the combined forces of
   - changes in computer, telecommunications, sensing and other technologies.
   - the push toward parts-per-million, or 6-sigma quality levels.
   - shorter product life cycles.
   - the push toward shorter run lengths?
2. What are the actual process control problems encountered in industry? Do current tools solve these problems?
3. Process control in both mundane and non-mundane services. Everyone says that the traditional tools apply, but there are few convincing case histories.
4. A merging of the process control philosophies and tools of SPC and process engineering.

5.3 Continuous Improvement

1. Is it possible to create a definitive synthesis of the various methods for problem solving and/or processes mapping analysis (e.g., Deming, Juran, Ichikawa, Xerox, ALCOA, IBM, etc.)?

5.4 and 5.5 Quality Assessment and Documentation

1. Identifying measures of product or service quality that predict customer satisfaction.

2. Improvements in data gathering, instrumentation, surveys, data analysis, etc. to focus a quality improvement process or to enable effective cause and effect analysis.
3. The management of data bases to support process control and process improvement (both Kaizen and innovation).

Note: All of the above issues are equally relevant to quality assurance of end products, work-in-process, support services and business processes and incoming supplies of goods and services.

Other Contributing Groups

The Center for Quality and Productivity Improvement University of Wisconsin-Madison

To rise to the challenge of the international quality revolution, the Center for Quality and Productivity Improvement was founded at the University of Wisconsin-Madison in October 1985 by Professor George E. P. Box and the late William G. Hunter. The problem of quality and productivity improvement is multidisciplinary, requiring input from and interaction among many different fields. The Center is located administratively in the College of Engineering and is jointly sponsored by the School of Business and the College of Letters and Science.

The objectives of the Center are:

- to conduct innovative practical research in modern methods of quality improvement that cannot be carried through economically by industries on their own;
- to disseminate our findings to industry through reports, publications, seminars, conferences, videotapes, and internships;
- to provide a reliable guide to how managers, engineers, and other personnel should be trained in modern quality techniques;
- to be a forum for the dynamic exchange of ideas among experts in various disciplines, from industry and government as well as academia.

In these ways, the Center will contribute to the improved functioning and increased success of organizations of all kinds, and to increased fulfillment of individuals working in those organizations.

Annotated descriptions of the Center's research reports can be found in the bibliography in Section 6 of this report.

Research at Deming User Groups

Deming User Groups are a network of academics and practitioners who raise research questions and seek practical answers in developing the Deming philosophy. The Deming philosophy has at its core Deming's 14 Points and Deming's System of Profound Knowledge. Profound Knowledge has four parts:

- Appreciation for a system
- Theory of Variation
- Theory of Knowledge
- Psychology

Examples of topics under investigation:

- Analytic versus enumerative studies
- What to do instead of performance appraisals
- Elimination of incentive pay systems
- Elimination of arbitrary numerical goals

Some Deming User Groups Around the Country

Name	Organization	Address	Phone
Carolyn Bailey	Indy Quality	P.O. Box 1190 Carmel, IN 45032	317/846-3117
Nancy Brout	PACE	1234 Market St., Ste. 1800 Philadelphia, PA 19107	215/972-3977
Wayne Steinberg	Spartanburg Area Chamber of Commerce	P.O. Box 1638 Spartanburg, SC 29304	803/594-5000
Dan Walker	Training Source	1787 Tribule Rd., #B Sacramento, CA 95015	915/646-9764
Debbie Ray	Ohio Quality & Productivity Forum	1973 Edison Drive Piqua, OH 45359	513/778-8900
David Markovitz	Deming Mgmt. Alliance of Southern Calif.	1125 N. Wright St. Santa Ana, CA 92701	714/262-1535
Bruce Tenpas	North Central Deming Mgmt. Forum	7801 E. Bush Lake Rd., #360 Bloomington, MN 55438	612/893-0575

Some Deming User Groups Around the Country - Continued

Name	Organization	Address	Phone
Dan Robertson	Bay Area Deming Users Group	c/o 3 Com Corp. 5400 Bayfront Plaza Santa Clara, CA 90552-8145	403/764-5000 ext. 7150
Milton Chen	Deming User Group-San Diego	San Diego State U San Diego, CA 92182	619/594-2474
Jim Gibson	Southwest VA	P.O. Box SVCC Richlands, VA 24641	703/984-7652
Dr. Gene Masters	Atlanta Area Deming Study Group	P.O. Box 48856 Atlanta, GA 30362	404/333-7075

GOAL/QPC Research Committee

Mission

To provide the best past, present, and future understanding of Total Quality Management.

Understanding includes:

- Simplifying knowledge into a usable process
- Identifying best leading edge methods
- Focusing on core TQM principles

Strategies

Strategy for ensuring an accurate and complete definition of Total Quality:

- Work with each of six Quality schools in Japan
- Identify and translate key documents
- Study with Research Committee members and key students of Total Quality in the U.S. and Japan

Strategy for research on implementation:

- Determine the most effective strategy for optimizing the transformation to Total Quality
- Assist companies in making the transition to Total Quality by building tools and systems into a usable process
- Determine ways to push forward the frontiers of Advanced Total Quality Management

Research Reports

Research papers and briefing reports are prepared by GOAL/QPC Research Committee teams on implementation issues and translation topics. These reports are available for general distribution to research committee companies and ultimately to the general public.

Committee Research Teams

The GOAL/QPC Research Committee is composed of research teams, which study and develop strategies for company transformation to Total Quality Management. The research ideas preliminary list for 1992 is listed below. It is an order of interest and viability based on committee members' votes.

1. Human dimension (empowerment, etc.)
2. Strategic information systems
3. Integrated planning/strategic planning
4. Fostering creativity and innovation in processes
5. Cycle time reduction
6. QFD (Advanced)
7. Kansei engineering
8. Process measurements
9. System dynamics (Senge/Forester)
10. Business process re-engineering
11. Leadership
12. Baldrige self-assessment
13. Flexible budgeting/budget tied to activity-based accounting
14. Process management for re-engineering
15. Executive training/education
16. Relationship of Theory of Constraints to TQM (Goldratt)

After intensive discussion and evaluation, committee members combined some topics and formed teams to address the following four areas. Some topics not chosen for work by the committee are being pursued by GOAL/QPC researchers.

Human Dimension Team

This team is investigating the impact of Total Quality Management on the human dimension of organizations. Members have conducted numerous organizational site visits. The visits are being used to generate a preliminary

matrix which will illustrate patterns, commonalities and differences in how the human element is addressed among successful organizations.

Process Re-engineering Team

This team is using the concepts of Constraints Management and Strategic Information Systems to illustrate a model for process re-engineering.

Critical Processes Team

The Critical Processes team's focus has been on the evaluation of best practices in identifying and measuring the critical processes of an organization. Projected output for the team is a model for addressing critical processes which merges the best of existing models and integrates two frequently divergent pathways in critical processes management: an exclusive focus on the customer and an exclusive focus on organizational vision/objectives.

Advanced QFD Team

The Quality Function Deployment (QFD) team continues its pursuit of advanced QFD techniques and concepts. Key areas of focus for 1992 include the Voice of the Customer table and cost deployment issues.

Juran Institute — Published Research

Juran Institute, its founder Dr. J. M. Juran, and several institute staff have published some of the leading texts in the field of quality. Each of these is based on extensive experience and research in the application of the quality disciplines in a wide variety of industrial and international settings. Some of these publications include:

- Juran on quality leadership
- Juran on quality by design
- Juran's quality control handbook
- quality planning and analysis
- managerial breakthrough
- modern methods for quality control and improvement
- curing health care
- quality process management
- making quality happen: upper managers' role
- total quality management: a practical guide
- total service quality

- quality improvement tools
- business process quality management

Juran Foundation:

The Juran Foundation is a nonprofit entity established to promote and support research in quality management. It is an entirely separate entity from the Juran Institute. As part of its mission, the Juran Foundation has provided educational materials to a number of colleges and universities. The Juran Foundation welcomes the opportunity to expand its support of research and teaching in higher education. For additional information, contact Juran Institute, Inc., P.O. Box 811, Wilton, Connecticut 06897-0811.

Research Topics: Joiner Associates Inc.

3800 Regent Street
Madison, Wisconsin
608-238-8134

Current Research Topics

- Problem solving methods
- Voice of the Customer
- Hoshin Kanri/Policy Deployment
- Performance Appraisals

Publications

- *The Team Handbook* by Peter R. Scholtes
- *Joiner 7-Step Method*
- *Recent Technical Bulletins*
- *Six Principles at the Heart of Quality* by Peter R. Scholtes
- *Learning How to Learn Faster: The Key to Improvement and Innovation* by Brian L. Joiner
- *Creating Robust Work Processes* by Ronald D. Snee
- *Labor-Management Cooperation: The Experience of NUMMI/UAW and Its Impact on United States Industrial Relations* by Joel D. Smith
- *Just-In-Time Manufacturing* by George Hettich
- *What's Missing in Statistical Education* by Ron Snee
- *Design, Marketing and Quality Management: Parts of a Whole* by William H. Lawton

American Productivity and Quality Center

The American Productivity & Quality Center (APQC), in Houston, Texas, is a nonprofit organization that works with business, labor, government, and academia to improve productivity, and quality of work life. Through its library search services, the following research documents were provided:

Title (Order #)

- Managing of Transformation Phases to TQ Excellence in a Small Mfg. Co. - 1991 (AAD92-16441)
- Evaluation of Organizational Role Conflict and Its Impact on TQM at Government Laboratory - 1991 (AAD92-12115)
- An Empirical Study of TQM Practices in U.S. Manufacturing Firms - 1991 (not available)
- The Change to TQ: Phenomenological Insights from Corporate Quality Executives - 1991 (AAD92-07104)
- Economics in TQ Control - 1991 (AAD92-03876)
- Concurrent Design Engineering, the Key to Successful Implementation of TQM - 1990 (AAD13-42843)
- Development of a Model for TQM in Health Care - 1990 (AAD91- 07671)
- Planning and Implementing Dynamic TQ Control Systems: A Research on Mexican Manufacturing Companies - 1990 (AAD90-26565)

For additional information, contact the APQC at: 713-681-4020.

Current Research Issues in Japan

The articles that were published between January 1991 and July 1992 were described for three top research journals in Japan. Their content was analyzed and is summarized here.

Summary of the Journal "Total Quality Control" by JUSE

- The journal is still covering "basic" topics such as data gathering, the seven basic tools, the seven management tools, and improving QC Circles.
- Multivariate analysis is a hot topic and also methods to handle ordered categorical data.

- Some emphasis was placed on service industries, especially multivariate analysis and quality assurance.
- EC 1992 and ISO 9000 were discussed frequently.
- The relationship between TQC and corporate strategies was explored.
- The relationship between market research and QFD was explored.
- The relationship between new Japanese management and TQC was explored.
- The relationship between TQC and the environment was explored.
- Much time was spent on the future of TQC.
- Human resource aspects such as women in the work place, aged workers, ergonomics (employees and customers), and employee satisfaction were discussed.
- Issues such as product liability, computer virus, and ethics were discussed.
- There was much discussion on TQC in software development and R & D
- One article on: What is benchmarking?
- One journal issue was on the relationship between quality and aging.
- Process design seemed to be a very important topic.
- Policy Management was a popular topic.
- Deming Prize companies and other companies were profiled.
- The application of tools and concepts seemed very important.
- The New England area and Milliken were discussed.

Symposiums:

Name	Number
Quality Control	52 nd
Reliability and Maintainability	21 st
Quality Control Study Team	21 st
Sensory Inspection	21 st
Multivariate Analysis	15 th
Seven Management Tools	12 th
Quality Control of Software Production	11 th
Service Industries QC	7 th
Software Production QC Study Team	3 rd
Quality Function Deployment	2 nd
Ergonomics	2 nd

Summary of the Journal of Japanese Society for Quality Control by JSQC

The following summarizes research directions in articles published between January 1991 and July 1992.

- Technical topics included:
  - ➢ Beta-binomial approximation to a compound normal
  - ➢ Weibull distribution (estimation)
  - ➢ Exponential distribution (estimation)
  - ➢ Split-plot designs
  - ➢ Orthogonal arrays
  - ➢ Probability paper for inverse Gaussian distribution
  - ➢ Ordered categorical data
  - ➢ Acceptance sampling
- There appears to be a great emphasis on SQC training methods.
- Process capability and production process control were discussed.
- The environment appears to be a concern as the relationship between environmental problems & QC was explored and sustainable development was discussed.

- Problem-solving was a popular topic with the discussion on problem-solving in general, the QC Story, and the relationship between problem solving and PDCA.

Summary of the Journal Standardization and Quality Control by JSA

The following summarizes research directions in articles published between January 1991 and July 1992.

- There seemed to be much emphasis placed on the 21st century. Also, there was discussion on globalization and internationalization. Harmony was mentioned more than once, especially harmony between the individual, industry, culture, and government.
- Regular sections in the journal included: Quality Manual, TPM, Taguchi Methods, and OA.
- Measuring the environment and product liability appeared to be very important topics.
- Simultaneous engineering at Ford and human-machine interface were explored.
- Some emphasis was placed on improving corporate quality.
- Standardization (as might be expected) was a very popular topic. Especially company-wide standardization and the role standardization in daily life.
- Customer satisfaction was a special topic for one journal issue.
- Multivariate analysis was a popular topic.
- Much emphasis was placed on ISO 9000.
- Nishibori-Ryu.
- Turkey and Greece (three part series).
- Company examples were prevalent.
- 25th Anniversary of the National Meeting on QC and Standardization.

6. Annotated Bibliography

Section Three

- *Quality Control: An Annotated Bibliography by Carol Krismann.* Quality Resources, 1988. This book provides an annotated bibliography of works related to TQ through 1987.
- *The Source: A Total Quality Management Information Guide* edited by GOAL/QPC, Methuen, MA, 1992. This book provides an annotated bibliography of resources related to TQ through 1991.

Section Five

Research Agendas

- *Issues for University Research in Total Quality Control* by Peter J. Kolesar. The Deming Center for Quality Management, Columbia University, 1991.
- *Scientific Quality Management and Management Science* by Peter J. Kolesar. The Deming Center for Quality Management, Columbia University, 1991.
- *Total Quality Management: A Research Agenda* by Harry V. Roberts. Graduate School of Business, University of Chicago, 1991.

Research Issues in Human Resource Management: Bibliography

BEMOWSKI, KAREN.

"The International Quality Study," *Quality Progress*, Vol. 24, Date: November 1991, pp. 33-37.

TERMS: Quality control; Employee involvement; Customer satisfaction; Strategic planning.

ABSTRACT: The International Quality Study, conducted by the American Quality Foundation and Ernst & Young, examines the quality management practices of 4 industries in Canada, Germany, Japan, and the U.S. Some of the findings are:

1. Japan does not organize the majority of its work force into teams that focus on quality programs, but it does have the highest rate of employee participation in regularly scheduled meetings about quality.
2. Businesses in all of the countries except Japan expect to increase their involvement of employees in quality-related teams.
3. About 40% of the businesses in Canada, Japan, and the U.S. place primary importance on customer satisfaction in strategic planning; about half as many (22%) of German businesses do so.

Bibliography: Human Resource Management

4. Japan dramatically leads the other countries in the routine use of process simplification and cycle time reduction. About half of the Japanese businesses use these practices more than 90% of the time.

BOWEN, DAVID AND LARRY GREINER.

"Moving from Production to Service in Human Resources Management," *Organizational Dynamics*, Summer 1986, pp. 35-53.

TERMS: Customers, human resources.

ABSTRACT: Describes how to implement TQM principles within the HRM department.

BOWEN, DAVID AND EDWARD LAWLER III.

"Total Quality-Oriented Human Resources Management," *Organizational Dynamics*, Spring 1992.

TERMS: Changing human resource practice; total quality; customer focus.

ABSTRACT: Total quality must be seen as opportunity not threat for HR management with TQM effort closely integrated with HR department activities. First step to insure HR department's credibility in organization is to redesign HRM department to fit TQM principles. Next, effort must be made to improve the process of selection, development and training, career development, performance management, pay systems, and labor relations. Five themes emerge across the different quality-oriented HR practices, setting them apart from conventional HR practices. They are:

1. a focus on the organization, rather than the job;
2. support for group performance;
3. egalitarianism, rather than hierarchy;
4. change, rather than stability; and
5. participation, rather than command and control.

BURROWS, PETER.

"Corporate Culture Is the Next Quality Frontier," *Electronic Business*, Vol. 17, October 7, 1991, pp. 64-66.

TERMS: Quality control; Corporate culture; Techniques; Improvements; Employee involvement.

ABSTRACT: Today's companies need a quality corporate culture, where information moves freely, artificial barriers are systematically dismantled, and employees are enthusiastic and satisfied in their work. Veterans of the quality movement say that technological quick-fixes and revised organizational

structures are not as important as better people management aimed at soliciting the expertise of each employee. The increased focus on the people part of the pursuit of excellence is a sign of the maturing of the quality revolution. Some companies are achieving significant quality improvements by empowering employees and decentralizing decision making. Industry officials note that the decentralized approach to quality management also increases the ability to quickly respond to changes in the market. Reducing the use of outside consultants is an early sign of a more mature employee-based quality campaign.

CARR, CLAY.

"Injecting Quality into Personnel Management," *Personnel Journal*, September 1987, pp. 43-51.

TERMS: Quality, human resources.

ABSTRACT: Describes how to implement TQM principles within the HRM department.

COLE, ROBERT E.

"Different Quality Paradigms and their Implications for Organizational Learning," Paper presented at the Conference: Japan in a Global Economy — a European Perspective. Stockholm School of Economics, September 5, 1991. Revised version to be published in Conference volume edited by Ronald Dore and Masahiko Aoki to be published by Oxford University Press.

TERMS: Organizational Learning, Taylorism, routines, motivation, capability, opportunity.

ABSTRACT: Explores the nature of organizational learning as distinct from individual learning. Shows the different implications of traditional quality paradigm and new quality paradigm for organizational learning. Explores critical elements in new quality paradigm and shows their consequences for organizational learning as reflected in contribution to motivation, capacity and opportunity to bring about change.

FORSHA, HARRY I.

"The Pursuit of Quality Through Personal Change: Part 1," *Quality Progress*, Vol. 25, January 1992, pp. 57-61.

TERMS: Quality control; Improvements; Behavior modification; Roles. Psychological aspects; Problem solving.

Bibliography: Human Resource Management

ABSTRACT: The Pursuit of Quality Through Personal Change provides simple, practical concepts and methods for improving the quality of people's lives and businesses, beginning with the process of personal change. The process of personal change is at the heart of the pursuit of quality. By combining ideas from the areas of personal improvement, organizational behavior, and structured problem solving, it is possible to develop a simple and powerful methodology for personal change. The methodology is based on 5 assertions:

1. Conformance to requirements (a definition of quality) can form the basis for improvement.
2. The process of personal change can be defined, described, and managed.
3. The process of personal change can be applied to groups.
4. Structured problem-solving techniques can be applied to both personal and business situations.
5. Change is constant. The process of personal change is denial, anger, negotiation, depression or decision, and acceptance or action.

HAMMONS, CHARLES AND GARY A. MADDUX.

"The Fine-Tuned Organization," *Quality Progress*, Vol. 25, February 1992, pp. 47-48.

TERMS: Quality control; Corporate culture; Internal public relations.

ABSTRACT: The goal of a quality-oriented business is to satisfy the needs and demands of internal and external customers by supplying them with quality goods and services. In the quality-oriented business, hiring is the first step in acquiring the necessary human talents, which are enhanced by education and training. Employees enter a continuous improvement process, which rewards the organization with a more competent, competitive work force and rewards employees with a more fulfilling work life. A business may be compared to an orchestra, which is composed of many different instruments, all playing in harmony. The various departments of a business must work together in synergy to produce a satisfying output. The leader of a business is similar to a conductor. The company's dynamic standard of production is similar to the musical score. Adhering to a dynamic standard, one that can be followed and continuously improved, ensures a process that provides a quality product with minimal variation.

Bibliography: Human Resource Management

HARCOURT, JULES, VIRGINIA RICHERSON AND MARK WATTIER.

"A National Study of Middle Managers' Assessment of Organization Communication Quality," *Journal of Business Communication*, Vol. 28, Fall 1991, pp. 348-365.

TERMS: Middle management; Communication; Studies; Quality; Statistical analysis.

ABSTRACT: An attempt was made to determine the quality of communication in organizations as assessed by a national sample of middle managers. A second goal was to compare one company's communication quality assessment data to the national survey findings. A questionnaire was mailed to 3,602 middle managers across the U.S. and to 36 managers in a small marketing organization. Frequency distributions, cross-tabulations, and Chi-square tests were used to analyze the national data and to make comparisons with company data. The national sample of middle managers assessed the quality of communication in their organizations as quite poor. Over 62% of the respondents disagreed with the statement that the quality of the information they receive is good. Both network communication and the grapevine were frequently ranked as better sources of information than was formal communication.

HENDRICKS, CHARLES AND ARLENE TRIPLETT.

"TQM: Strategy for 90s Management," *Personnel Administration*, December 1989, pp. 42-48.

TERMS: Total quality management; human resources

ABSTRACT: Stresses importance of human resources in quality.

KAHNWEILER, WILLIAM.

"HRD and Empowerment," *Training and Development*, November 1991, pp. 73—76.

TERMS: Human resources department, empowerment.

ABSTRACT: Background on implementing TQM principles in HRM department.

KELBAUGH, RICHARD.

"Customer-Focused Process Improvement," *Journal for Quality & Participation*, Vol. 14, December 1991, pp. 84-90.

TERMS: Techniques; Teamwork; Problem solving; Customer satisfaction.

ABSTRACT: The customer focused process improvement (CFPI) model is one method used to fulfill the requirements of the global marketplace while

implementing a customer-focused improvement process. Once the vision, or business mission, is defined, the leader, together with staff, must identify the business issues and processes that will have the greatest impact on achieving the mission. The business structure should provide for clear delineation of process ownership. The process owner will define the preliminary boundaries and form the process improvement team (PIT). The PIT uses process mapping to develop a common understanding of the process. Models for process mapping range from a simple process flow chart to complex information flow maps designed to reflect organizational interrelationships of a process. The PIT identifies a process measurement to track how well the process is meeting key customer needs. Once a problem has been identified, the PIT looks for the cause of the problem. When this is fixed, the problem will be permanently prevented from recurring.

LAWLER, EDWARD II, SUSAN MOHRMAN, AND GERALD LEDFORD JR.

Employee Involvement and Total Quality Management: Practices and Results in Fortune 1000 Companies. San Francisco: Jossey Bass, 1992.

TERMS: Employee involvement, survey, total quality management.

ABSTRACT: Provides systematic national data on trends in employee involvement and its consequences. Examines relationships between employee involvement and total quality management. Asks the question: what combination of TQM and employee involvement has the most positive impact on organizational performance. In addition to addressing the extent and nature of employee involvement activities, examines what types of programs are adopted as part of TQM and how they interact with employee involvement. Differences between manufacturing and service firms are elaborated. Shows how when employee involvement and quality are managed as one integrated program or as two coordinated programs they are more likely to achieve desired performance results than if they are run as two separate activities.

LAMMERMEYER, HORST.

Human Relations: The Key to Quality. Milwaukee: Quality Press, 1990.

TERMS: Industrial psychology; training methods; quality control circles, philosophy.

ABSTRACT: Examines defects in Western approach to product quality as reflected in use of quality control circles, industrial psychology, managerial

training, unionism and weak communications. Shows how industrial psychology has contributed to better organizations and methods as well as identifies continuing weaknesses. Analyses training methods and how training should proceed to insure high quality products and services. Emphasizes the way people, not systems, can improve quality. Discusses underlying basis for success of Japanese quality circles in terms of the human element. Analyzes the role of philosophy as a supplement to industrial psychology in clarifying how to achieve quality in an economical fashion.

MAITAL, SHLOMO.

"Zen and the Art of Total Quality," *Across the Board*, Vol. 29, March 1992, pp. 50-51.

TERMS: Total quality; Communication; Teamwork.

ABSTRACT: Total quality management (TQM) is similar to other management concepts in that it demands the use of clean, clear language by groups who together diagnose problems and then act to solve them. Shoji Shiba, professor of business administration at Japan's Tsukuba University, teaches that the key to TQM is the clear use of language. Shiba is a top exponent of the KJ method — a system for organizing and drawing conclusions from data pioneered by anthropologist Jiro Kawakita. Shiba explains that there are two types of language: the language of affection and the language of facts. TQM requires the use of factual reports to solve problems. Unclear, misleading data lead to poor diagnosis of the problem. According to semanticist S.I. Hayakawa, good factual reports follow 2 rules:

1. They are verifiable.
2. They exclude, as far as possible, inferences, judgments, and loaded (emotional) words.

MATTHES, KAREN.

"Empowerment: Fact or Fiction?" *HR Focus*, Vol. 69, March 1, 1992, pp. 1, 6.

TERMS: Employee involvement; Implementations.

ABSTRACT: More employers are introducing employee empowerment programs to help their businesses stay competitive. As with other employee involvement (EI) programs, empowerment promises improved quality, productivity, employee morale, and motivation. Edward Lawler of the University of Southern California says that many companies have not thought empowerment through enough to know that they might have to redesign not

just a small part of their work space, but also their overall work structures. Lawler suggested that employers determine where empowerment works and where it does not within the company.

McDOUGALL, BRUCE.

"The Thinking Man's Assembly Line," *Canadian Business*, Vol. 64, November 1991, pp. 40-44.

TERMS: Teamwork; Industrial plants; Automobile industry; Recruitment; Improvements; Employee involvement; Quality control.

ABSTRACT: Since its C$400-million facility in Cambridge, Ontario, opened in 1988, Toyota Motor Manufacturing Canada Inc. has turned almost 1,000 young and inexperienced men and women into loyal, quality-conscious, and non-unionized autoworkers. The employees have increased their rate of production since 1988 to one car every 3.1 minutes from one car every 4 minutes. This was accomplished almost entirely by improvements suggested by workers. Toyota did not hire employees for experience but looked for applicants with communications skills, mental flexibility, affinity for teamwork, and an ability to find weaknesses in a process and improve it. By correcting problems, employees eliminate defects in vehicles and are encouraged to think about doing their jobs better. The company's thoughtful approach to management has inspired a quality-conscious work force and eliminated the need for a union. Toyota's employees earn wages comparable to unionized workers in other auto plants and receive better benefits.

PORTIS, BERNARD AND NEIL HILL.

"Making Employee Participation a Way of Life: Four Experiences," *National Productivity Review*, Vol. 10, Autumn 1991, pp. 481-489.

TERMS: Employee involvement; Participatory management; Quality of work; Quality circles.

ABSTRACT: Employee involvement is a necessity in today's business world. Efforts at employee involvement in established organizations generally start with a specific participative program. A lack of research in this area has led some experts to conclude that employee involvement programs cannot be sustained for more than 1 or 2 years. However, recent studies show that these programs can become more effective over time, enabling some firms to extend employee participation into many areas of work so that employee participation becomes a way of life. Four case studies are examined in which

quality circles or quality of working life programs were introduced as parallel or separate activities to the regular work organization. Three of the organizations were very successful in involving employees and managers. The 4th firm introduced its program in a rushed manner and accomplished little because of employees' and management's lack of understanding and support.

ROTH, WILLIAM, JR.

"Quality Through People: A Hit for HR," *Personnel Management*, November 1989, pp. 50-52.

TERMS: Quality, people

ABSTRACT: Stresses importance of human resources in quality improvement.

ROTH, WILLIAM JR.

"Do's and Don'ts of Quality Improvement," *Quality Progress*, Vol. 23, August 1990, pp. 85-87.

TERMS: Employee attitudes, quality improvement process, organizational strategies

ABSTRACT: Elaborates the common failings of quality initiatives from organizational perspective with numerous references to role of HR.

SCHAFFER, ROBERT H. AND HARLOW B. COHEN.

"Today's Business Problems Require New HR Strategies," *Human Resources Professional*, Vol. 3, Summer 1991, pp. 13-18.

TERMS: Human resource management; Organizational behavior; Strategic planning.

ABSTRACT: Today, human resources (HR) professionals are welcomed as key players in quality and productivity initiatives and continuous improvement. However, the traditional mode of delivering packages of professionally correct solutions, which worked so well in staffing, training, salary administration, and traditional HR tasks, will result in disaster if used in meeting the new competitive challenges. To succeed, HR professionals need to adopt a new process, called the breakthrough approach. This approach:

1. begins with "results first,"
2. exploits untapped potential and existing resources,
3. gives line management primary accountability for designing the steps to achieve performance improvement, and
4. emphasizes a gradual, "small-win" approach at the beginning rather than a

Bibliography: Human Resource Management

corporate-wide extravaganza. Successful implementation of a breakthrough project involves 3 key actions:

1. Design each project for success.
2. Use each project as a vehicle for organizational development.
3. Expand on success and create a continuous improvement process.

SCHLOSSBERG, STEPHEN.

"Quality in the Workplace and the Environment to Support It," *Journal for Quality and Participation*, Vol. 14, June 1991, pp. 18-24.

TERMS: Unions; Labor relations; Employee involvement. Automobile industry; Participatory management.

ABSTRACT: Richard E. Walton of Harvard Business School says that, to create a successful workplace, an organization must:

1. be world class in both economic and social performance,
2. be based on employee commitment rather than compliance,
3. exploit and coordinate technology, and
4. undergo radical changes in union-management relations. Examples of world-class organizations being as committed to social performance as to economic performance are the efforts of Ford Motor Co. and the United Auto Workers (UAW) in an employee involvement plan and the constructive involvement of the UAW in work life at General Motors' Shreveport Truck and Bus plant. The characteristics that identify a world-class labor-management effort to combine social and economic performance to produce quality goods and a desirable social dimension include:

1. Everyone in the enterprise has a stake in its ultimate success.
2. All employees know their performance has a direct bearing on the end results.
3. Egalitarian principles govern.

SCHULER, RANDALL AND DREW HARRIS.

"Deming Quality Improvement: Implications for Human Resource Management in a Small Company," *Human Resource Planning*, Vol. 14, 1991, pp. 191-207.

TERMS: Quality improvement; human resource management.

ABSTRACT: Stresses importance of human resources in quality improvement.

Bibliography: Human Resource Management

SHETTY, Y. K.

"A Point of View: Seven Principles of Quality Leaders," *National Productivity Review*, Vol. 11, Winter 1991/1992, pp. 3-7.

TERMS: Competitive advantage; Productivity; Corporate culture.

ABSTRACT: The experiences of the U.S. quality leaders, such as Hewlett-Packard and McDonald's, suggest that quality is achieved by making the improvement process a permanent part of a company's culture. The tactics are fairly simple, but incorporating them in day-to-day operations is a formidable challenge. However, payoffs are great for enhanced quality can provide powerful leverage to achieve competitive advantage and superior business performance. Certain principles are shared by all quality-conscious companies. They are:

1. Quality improvement requires the firm commitment of top management.
2. Quality is a strategic issue.
3. Employees are the key to consistent quality.
4. Quality standards and measurements must be customer-driven.
5. Many programs and techniques can be used to improve quality.
6. All company activities have potential for improving product quality; therefore, teamwork is vital.
7. Quality is a never-ending process.

SNELL, SCOTT AND JAMES DEAN JR.

"Integrated Manufacturing and Human Resource Management: A Human Capital Perspective," *Academy of Management Journal*, August 1992, pp. 467-504.

TERMS: Advanced manufacturing technology, total quality management, Just-in-Time, human resource management

ABSTRACT: Study examines the relationship between integrated manufacturing defined as the use of advanced manufacturing technology, JIT and total quality and human resource management from a human capital perspective.

SCHONBERGER, RICHARD.

"Is Strategy Strategic? Impact of Total Quality Management on Strategy," *The Executive*, Vol. VI, August 1992, pp. 80-87.

TERMS: TQM, strategic planning objectives

ABSTRACT: TQM moves firms toward a few common strategic planning objectives namely: continuous improvement in quality of goods and services,

responsiveness and flexibility of internal and supplier processes and waste and cost elimination.

THOMASON, GEORGE F.

"The Management of Personnel," *Personnel Review*, Vol. 20, 1991, pp. 3-10.

TERMS: Human resource management; Workforce planning; Organization development.

ABSTRACT: There are 4 main types of business strategy:

1. differentiation,
2. cost leadership,
3. focus, and
4. asset parsimony.

Each makes its own demands for and upon different resources. In each case, management faces the necessity of rethinking its approaches to the task of efficiently acquiring resources, and particularly the labor resource, from which a competitive advantage might be derived. The 4 types of human resource (HR) strategy are:

1. the selection strategy, which may provide the cheapest way of achieving HR mobilization and motivation where the mission emphasizes the need for quality output and the labor-resource requirement can be met by the external labor market,
2. the supervision strategy, which involves the development of a framework of imposed or agreed rules and procedures,
3. the interventionist development strategy, which may have to be introduced to supplement the supervision strategy and give greater versatility, and
4. the total learning partnership, in which a complex status contract binds workers more firmly to the enterprise.

WOLLNER, GEORGE E.

"The Law of Producing Quality," *Quality Progress*, Vol. 25, January 1992, pp. 35-40.

TERMS: Total quality; Implementations; Organization development; Productivity; Customer satisfaction; Employee involvement.

ABSTRACT: U.S. business, labor and government desperately need what total quality (TQ) has proven it can deliver: organizations in which customer satisfaction, employee satisfaction, and productivity continue to increase. An

Bibliography: Human Resource Management

analysis of successful TQ efforts indicates that producing quality is similar to producing any other market-based product. TQ success is heavily dependent on leaders who use powerful non-economic incentives to motivate the workforce. TQ is a situation of supply and demand, and achieving it is a matter of incentive. While money is an important incentive, successful TQ efforts also deliver powerful nonmonetary benefits, such as:

1. achievement,
2. a sense of belonging,
3. recognition,
4. self-esteem,
5. a feeling of control over one's life, and
6. the ability to live up to personal ideals.

Employee empowerment is the key leadership act that will make effective use of non-economic benefits. It is the leader's job to identify the incentive controller and align the organizational incentive system to achieve the desired results.

YEAMANS, WILLIAM.

"Building Competitiveness Through HRD Renewal," *Training and Development Journal*, October 1989, pp. 77-82.

TERMS: Human resources development; competitiveness, quality

ABSTRACT: Stresses importance of human resources in quality.

Research Issues in Customer-Supplier Relationships: Bibliography

Citations:

- Asanuma, B., "Manufacturer-supplier relationships in Japan and the concept of relation-specific skill", *Journal of the Japanese and International Economies* 3, 1989, pp. 1-30.
- Clark, K.B. & T. Fujimoto, *Product Development Performance*, Boston: Harvard Business School, 1991.
- Cusumano, M.A. and A. Takeishi, "Supplier relations and management: A survey of Japanese, Japanese-transplant, and U.S. auto plants," *Strategic Management Journal*, Vol. 12, 1991, pp. 563-588.
- Helper, S., "How much has really changed between U.S. automakers and their suppliers?" *Sloan Management Review*, Summer, 1991.

Bibliography: Customer-Supplier Relationships

- Lincoln, James, Michael Gerlach and Peggy Takahashi, "Keiretsu networks in the Japanese economy: A dyadic analysis of intercorporate ties, " *American Sociological Review*, October, 1992.
- Kamath, R. R. and J. Liker, "Supplier dependence and innovation: A contingency model of suppliers' innovation activities," *Journal of Engineering and Technology Management*, 7, 1990, pp. 111-127.
- Porter, M. E., *Competitive Advantage*, New York: Free Press, 1985.
- Smitka, M. J., *Competitive Ties: Subcontracting in the Japanese Automotive Industry*, New York: Columbia University Press, 1991.
- Walker, G. and D. Weber, "A transaction cost approach to make-or-buy decisions," *Administrative Science Quarterly*, 29, 1984, pp. 373-391.
- Williamson, Oliver. *Markets and Hierarchies*, New York: Free Press, 1975.

References:

ASANUMA, BANRI.

"Manufacturer-Supplier Relationships in Japan and the Concept of Relation-Specific Skill", *Journal of the Japanese and International Economies*, Vol. 3, 1989, pp. 1-30.

TERMS: Longstanding customer-supplier relationships, supplier skill, learning.

ABSTRACT: This paper investigates manufacturer-supplier relationships in Japan based on field research on two major industries. It shows that various modes of relations exist and that longstanding relations are more densely distributed where customized parts are transacted. It also shows that this phenomenon can be ascribed to ratings exercised by the purchasing firm on some skill accumulated by each supplier. The concept of multidimensional relation-specific skill accumulated by each supplier through learning and technological investments is related to Aoki Masahiko's work on relational quasi-rent and Williamson's scheme to classify transactions.

BHOTE, KEKI.

Strategic Supply Management. New York: American Management Association, 1989.

TERMS: Partnership, supplier quality, measurement, cost reduction, cycle time management.

ABSTRACT: This book explores the various dimensions of forging a customer-supplier partnership and identifies the improvement of supplier quality as the

centerpiece of supply management. It also provides a good introduction to a number of technical tools such as design of experiments, SPC, fault tree analysis etc. The influence of the Japanese model of customer-supplier relationships is strong. There is no attempt to link the analysis to scholarly concerns.

CUSUMANO, MICHAEL A. AND AKIRA TAKEISHI.

"Supplier Relations and Management: A Survey of Japanese, Japanese-Transplant, and U.S. Auto Plants", *Strategic Management Journal*, Vol. 12, 1991, pp. 563-588.

TERMS: Suppliers, automobile industry, Japanese management, transplants.

ABSTRACT: This article presents the results of a questionnaire survey sent to a sample of automobile manufacturers in the United States and Japan (including Japanese managed plants in the United States) during the Spring of 1990. The date support observations that Japanese and U.S. practices tend to differ in key areas and Japanese suppliers perform better in dimensions such as quality (defects) and prices (meeting targets, reducing prices over time); and that Japanese managed auto plants established in the United States have, in general, adopted Japanese practices and receive extremely high levels of quality from Japanese as well as U.S. suppliers. These findings provide evidence that Japanese practices and performance levels are transferable outside Japan and suggest that considerable improvements are possible for U.S. suppliers supplying U.S. auto plants. In addition, the survey indicates that U.S. firms have adopted at least some practices traditionally associated with Japanese firms, apparently reflecting some convergence toward Japanese practices and higher performance levels in supplier management. The article does not explicitly analyze the specific ways in which these relationships lead to higher quality.

HELPER, SUSAN.

"How Much Has Really Changed Between U.S. Automakers and Their Suppliers?", *Sloan Management Review*, Summer, 1991, 1991, pp. 15-28.

TERMS: Supplier-Customer relations; "voice"; long-term contracts; supply base rationalization.

ABSTRACT: Author presents the results of a survey of U.S. automotive suppliers and answers two questions: what is the extent of the changes in buyer-supplier relations, and what types of relationships lead to better performance?

Bibliography: Customer-Supplier Relationships

While she notes significance changes, she also warns that dangerous countertrends could destroy the progress made so far. The author does not attempt to elaborate upon ways in which these changing relationships can improve quality.

KAMATH, RAJAN R. AND JEFFREY K. LIKER.

"Supplier Dependence and Innovation: A Contingency Model of Suppliers' Innovative Activities", *Journal of Engineering and Technology*, Vol. 7, 1990, pp. 111-127.

TERMS: Innovation, Manufacturer-Supplier Relations, R&D Strategy.

ABSTRACT: This paper explores the determinants of suppliers' innovative activities by developing a theoretical model of these activities and testing this model with data from a set of organizations that supply intermediate goods to the automotive Original Equipment Manufacturers in the United States. This contingency model assumes that the factors influencing product innovation by a supplier firm depend on a key characteristic of its environment — the degree of dependence on a specific automotive OEM. Statistical analysis of survey data on supplier innovative activity demonstrates that there are substantial differences in the factors leading to innovative activity in independent and dependent suppliers. While independent suppliers follow traditional economic models which argue that they will innovate only if they perceive favorable and calculable benefit-cost ratios, dependent suppliers are more willing to innovate in less clearly favorable circumstances if they are clear on what kinds of innovations are desired by their customers. The study results suggest ways in which these two types of suppliers should be managed. The article does not address the interorganizational relationships that can influence the supplier's activities and specifically the consequences for quality.

LINCOLN, JAMES, MICHAEL GERLACH AND PEGGY TAKAHASHI.

"Keiretsu networks in the Japanese economy: A dyadic analysis of intercorporate ties, " *American Sociological Review*, October, 1992.

TERMS: keiretsu, network, control, Japan

ABSTRACT: Analyzes the antecedents of commercial and financial transactions among large Japanese firms. Explores the impact of keiretsu on those transactions. Examines how keiretsu ties affect cross shareholding and interlocking directorates.

Bibliography: Customer-Supplier Relationships

WALKER, GORDON AND DAVID WEBER.

"A Transaction Cost Approach to Make-or-Buy Decisions," *Administrative Science Quarterly*, Vol. 29, 1984, pp. 373-391.

TERMS: Transaction Costs, Make-or-Buy Decisions Suppliers.

ABSTRACT: This study focuses on make-or-buy decisions as a paradigmatic problem for analyzing transaction costs. Hypotheses developed from Williamson's efficient boundaries framework were tested in a multiple-indicator structural equation model. The influence of transaction costs on decisions to make or buy components was assessed indirectly through the effects of supplier market competition and two types of uncertainty, volume and technological. In addition to transaction costs, the decisions were hypothesized to be predicted by both buyer production experience and the comparative production costs between buyer and supplier. The hypotheses were tested on a sample of make-or-buy decisions made in a division of a U.S. automobile company. The results show that comparative production costs are the strongest predictor of make-or-buy decisions and that both volume uncertainty and supplier market competition have small but significant effects. The findings are explained in terms of the complexity of the components and the potential pattern of communication and influence among managers responsible for making the decisions. This article does not extend its explanation of the make-buy decision to issues of quality nor does it address interorganizational relationships that are of an intermediate nature-neither make or buy.

Articles That Suggest Key Research Questions in Strategic Planning and TQ

The annotated articles listed in the pages that follow were selected primarily because they suggest research topics appropriate for TQ. It was not our intention to evaluate these articles and these articles were not selected because of the quality of their research content. The list simply provides examples relating to important research questions and is not comprehensive.

TITLE: Capital Resource Allocation for Strategic Quality Management

AUTHORS: Andreou, Stefanos A.

JOURNAL: International Journal of Technology Management Vol: 6 Iss: 3,4 Date: 1991 pp: 415-426 Jrnl Code: ITN ISSN: 0267-5730

Bibliography: Strategic Planning

TERMS: Quality control; Resource allocation; Market shares; Profitability; Strategic planning; Capital budgeting

CODES: 5320 (Quality control); 2310 (Planning); 3100 (Capital & debt management)

ABSTRACT: Product and process quality is of critical importance in today's manufacturing environment. New technologies can create significant opportunities for quality improvements, which in turn could result in increases of future profitability. Thus, there is a need for systematic evaluation of investment alternatives and trade-offs. Traditional capital budgeting methods should be augmented to establish better quantitative approximations of the benefits and costs of quality, which are often treated as intangible in today's capital appropriation proposals. A financial evaluation framework is proposed that integrates recently developed techniques for quantifying the impact of quality improvements. These techniques include:

1. a new overhead allocation method that uses quality cost drivers,
2. modern finance principles that help quantify growth opportunities created by quality differentiation, and
3. empirical studies that link quality with market share and profitability.

Charts. Graphs. Equations. References.

TITLE: Decision-Making Participation Patterns: The Role of Organizational Context

AUTHORS: Connor, Patrick E.

JOURNAL: Academy of Management Journal Vol: 35 Iss: 1 Date: Mar 1992 pp: 218-231 Jrnl Code: AMA ISSN: 0001-4273

TERMS: Organizational behavior; Decision making; Pattern; Nursing homes; Effects; Employee involvement; Variance analysis; Comparative studies; U.S.

CODES: 2500 (Organizational behavior); 8320 (Health care industry); 9190 (United States); 9130 (Experimental/theoretical)

ABSTRACT: A study examined whether a particular internal variable, decision making, varied systematically with organizational context. Specifically, whether patterns of employee participation were discernible as a function of an organization's size, overall technical complexity, and profit-making orientation was investigated. Some 101 Oregon nursing homes served as the population for the study. The results showed strong main effects, but interaction effects varied. The main effects of size, skill level, and profit

Bibliography: Strategic Planning

orientation were strong, but weak 3rd-order interactions were confounded by strong 4th-order effects. The results indicated that certain contextual properties were indeed related to internal decision patterns. Charts. References.

TITLE: Supplier Relations and Management: A Survey of Japanese, Japanese-Transplant, and U.S. Auto Plants

AUTHORS: Cusumano, Michael A.; Takeishi, Akira

JOURNAL: Strategic Management Journal Vol: 12 Iss: 8 Date: Nov 1991 pp: 563-588 Jrnl Code: SMJ ISSN: 0143-2095

TERMS: Studies; Questionnaires; Automobile industry; Automotive supplies; Suppliers; Production planning; Statistical analysis; Implications

CODES: 5310 (Production planning & control); 8680 (Transportation equipment industry); 9130 (Experimental/theoretical); 9190 (United States); 9179 (Asia & the Pacific)

ABSTRACT: The results of a questionnaire survey sent to a sample of automobile manufacturers in the U.S. and Japan are analyzed. The data support observations that Japanese and U.S. practices tend to differ in key areas and Japanese suppliers perform better in such dimensions as quality and prices. Japanese-managed auto plants established in the U.S. have, in general, adopted Japanese practices and receive extremely high levels of quality from Japanese as well as U.S. suppliers. These findings provide evidence that Japanese practices and performance levels are transferable outside Japan and suggest that considerable improvements are possible for U.S. suppliers supplying U.S. auto plants. The survey also indicates that U.S. firms have adopted some Japanese practices, reflecting some convergence toward Japanese practices and higher performance levels in supplier management.

TITLE: Quality Up, Technology Down: Manufacturing Improvement Programs in Europe

AUTHORS: De Meyer, Arnoud; Ferdows, Kasra

JOURNAL: International Jrnl of Technology Mgmt (Switzerland) Date: 1991 pp: 136-153 Jrnl Code: ITN ISSN: 0267-5730

TERMS: Manufacturing; Roles; Corporate planning; Technology; Trends; Quality control; Surveys; Europe; Correlations; Statistical data

CODES: 2310 (Planning); 5320 (Quality control); 5310 (Production planning & control); 9175 (Western Europe); 9140 (Statistical data)

Bibliography: Strategic Planning

ABSTRACT: Over the last decade, it has been recognized that manufacturing is an important strategic weapon. For the most part, the research on manufacturing's role in the company's strategy is based on clinical case studies. The European Manufacturing Futures Project is a long-term project carried out at the European Institute of Business Administration (INSEAD). Its purpose is to gather data through a questionnaire on the manufacturing strategy of large European manufacturers. The most striking conclusions of the 6th survey include:

1. Quality remains the core of European manufacturing strategy.
2. Technology has lost some of its former appeal.
3. More attention is paid to organizational improvements than to developments in technology.
4. Success in performance improvement is always the result of a comprehensive set of long-term action plans. Charts. Graphs. References. Appendix.

TITLE: Achieving Total Quality Through Intelligence

AUTHORS: Fuld, Leonard M.

JOURNAL: Long Range Planning Vol: 25 Iss: 1 Date: Feb 1992 pp: 109-115 Jrnl Code: LRP ISSN: 0024-6301

COMPANY: Corning Inc (DUNS: 00-130-7735), Motorola Inc (DUNS: 00-132-5463), IBM Corp (DUNS: 00-136-8083), GTE Corp (DUNS: 00-129-3950), Milliken & Co (DUNS: 00-201-7440)

TERMS: Total quality; Many companies; Awards; Improvements; Information management; U.S.

CODES: 5320 (Quality control); 9190 (United States)

ABSTRACT: Information can provide the necessary drive for improving the quality of products and processes. A successful corporate intelligence program will capture, digest, and analyze information, in addition to monitoring customers, assessing suppliers, cost, and quality control, and speeding the flow of internal information. The Baldrige Award was created in 1987 to help companies increase their quality standards. Examiners for this award have identified quality gaps in many companies. The examiners use 5 key factors to assess companies:

1. customer focus,
2. meeting commitments,

Bibliography: Strategic Planning

3. process management and elimination of waste,
4. employee involvement and empowerment, and
5. continuous improvement. For all these factors, a company's information exchange is critical. Hundreds of companies in the U.S. and Europe are now in the process of building computer-based intelligence systems. If an intelligence program is going to help the quality effort, it must consciously lower the cost per unit of information and it must be given the time to grow and mature. Charts.

TITLE: Strategic Group Technique: Involving Managers in Strategic Planning

AUTHORS: Fulmer, William; Fulmer, Robert

JOURNAL: Long Range Planning (UK) Vol: 23 Iss: 2 Date: Apr 1990 pp: 79-84 Jrnl Code: LRP ISSN: 0024-6301

TERMS: Strategic planning; Roles; Upper management; Techniques; Problem solving; Stages; Seminars; Effectiveness

CODES: 2310 (Planning); 2130 (Executives)

ABSTRACT: Recently, considerable attention has been given to the challenge of implementing strategies after they have been developed. A process is described by which top management can be involved in strategic planning without losing the contributions of the chief executive officer, key senior managers, and the planning staff. The concept — strategic group technique (SGT) — which draws on management tools such as strategic long range planning and the off-site planning seminar, can help facilitate the strategic planning process in an organization by systematic organization of the planning job. The technique is particularly useful in large organizations that are relatively new to the process of strategic planning. Although SGT is based on ideas from both the organizational behavior and business policy areas, the total process is a unique answer to the difficult question of how the management team can be effectively and efficiently involved in strategic planning. A step-by-step application of SGT at a large industrial company is described. References.

TITLE: Thank Heaven for Complainers

AUTHORS: Harari, Oren

JOURNAL: Management Review Vol: 81 Iss: 1 Date: Jan 1992 pp: 59-60 Jrnl Code: MRV ISSN: 0025-1895

Bibliography: Strategic Planning

TERMS: Customer relations; Customer feedback; Competitive advantage; Quality control; Recommendations; Improvements; U.S.

CODES: 2400 (Public relations); 9190 (United States)

ABSTRACT: Instead of treating customer complaints as something to avoid or briefly patronize, companies would be better served by viewing these complaints as a source of strategic opportunity. Companies should be grateful to complaining customers because those customers:

1. are telling the company it still has a chance to keep their business,
2. are representing other dissatisfied customers who do not bother to complain, and
3. are educating the company about products that do not work, outdated features, incorrect invoices, and other symptoms of problems within the organization.

Complaining customers can act as strategic thermostats for a company and can actually help a business prosper. Listening to customers will be less costly than hiring someone to advise the company.

TITLE: Configuration Management — The Missing Link in Continuous Improvement?

AUTHORS: Kidd, Callum

JOURNAL: Management Services Vol: 35 Iss: 11 Date: Nov 1991 pp: 22-24 Jrnl Code: MNS ISSN: 0307-6768

TERMS: Production planning; Quality control; Product design; Continuous; Improvements; Methods; Comparative analysis; Competitive advantage; UK

CODES: 5310 (Production planning & control); 9175 (Western Europe); 7500 (Product planning & development)

ABSTRACT: The missing link between continuous improvement and traditional method study lies in the production of documentation procedures that are designed to accommodate this change process, not just try to control it. Thus, the missing step in the cycle is configuration management. Opportunities to improve configurations, processes, and facilities are always present. The ability to change faster and document better is the most certain route to survival. Continuous improvement is one objective to be considered, but increasing the rate of improvement is a much more essential one. Increasing both the change rate and the net benefit per change is the paramount objective. The change control process can best be regarded as a method for

Bibliography: Strategic Planning

absorbing change with the least disruption and as a process by which technical change requirements are transformed into commercial decisions. Changes required to a product should be made whenever improvements are required, not just in the development phase. Charts. Equations. Graphs.

TITLE: A Totally Integrated Management System

AUTHORS: Long, Ralph F.

JOURNAL: Management Decision (UK) Vol: 28 Iss: 7 Date: 1990 pp: 44-50 Jrnl Code: MGD ISSN: 0025-1747

TERMS: Strategic planning; Quality control; Performance appraisal; Rewards; Studies

CODES: 9130 (Experimental/theoretical); 2310 (Planning); 6100 (Human resource planning); 5320 (Quality control)

ABSTRACT: Organizational management systems tend to grow organically over time. As such, they frequently are at cross-purposes with overall objectives, systems, and cultures. This phenomenon is examined, with a particular emphasis on personnel management, motivation, and reward systems. It is suggested that the solution lies in combining the satisfaction of corporate objectives with the production of a standard of quality that meets the needs and expectations of customers and appropriately rewards the individual contribution of each employee. The 3 major elements of a business operation are:

1. the business plan,
2. the total management of quality, and
3. the process of performance-related appraisal and reward.

A properly developed business plan will be based on the need to communicate effectively, coordinate effectively, and control effectively. Benefits that accrue from a totally integrated management system include:

1. Managers at all levels are provided with a range of effective motivational tools with which to achieve through people.
2. Effective teams are developed at all levels within the organization.

Charts. Tables.

TITLE: Performance Measurement for World Class Manufacturing

AUTHORS: Maskell, Brian

JOURNAL: Management Accounting (UK) Vol: 67 Iss: 5 Date: May 1989 pp: 32-33 Jrnl Code: MAC ISSN: 0025-1682

Bibliography: Strategic Planning

TERMS: Manufacturing; Quality control; Performance standards; Just-in-time; Improvements

CODES: 8600 (Manufacturing industries); 5320 (Quality control)

ABSTRACT: New methods of measuring a firm's performance are required when world class manufacturing (WCM) techniques are introduced. The traditional performance measures are inadequate and sometimes misleading. WCM includes:

1. a new approach to product quality,
2. just-in-time production techniques,
3. a change in the way that the workforce is managed, and
4. a flexible approach to customer requirements.

Although the new performance measures that are being used by WCM firms vary considerably, they share seven common characteristics, specifically, they:

1. are directly related to the manufacturing strategy,
2. are nonfinancial,
3. vary between locations,
4. change over time,
5. are simple and easy to use,
6. provide fast feedback, and
7. are intended to teach rather than to monitor.

Many of the performance reports can be produced easily from the computer system used for manufacturing planning and control.

TITLE: The Impact of Flexible Automation on Business Strategy and Organizational Structure

AUTHORS: Parthasarthy, Raghavan; Sethi, S. Prakash

JOURNAL: Academy of Management Review Vol: 17 Iss: 1 Date: Jan 1992 pp: 86-111 Jrnl Code: AMR ISSN: 0363-7425

TERMS: Flexible manufacturing systems; Implementations; Organizational structure; Strategic planning; Behavioral decision theory; U.S.

CODES: 2320 (Organizational structure); 2500 (Organizational behavior); 5310 (Production planning & control); 9130 (Experimental/theoretical); 9190 (United States)

ABSTRACT: A framework explains the technology-strategy-structure relationship in the context of the current trends toward flexible automation (FA). It incorporates the influential as well as the implemental role of technology in

Bibliography: Strategic Planning

the strategic management process. It describes a firm's technology as evolutionary and explains its influence over strategy and structure based upon its changing competencies. Ideally, the framework calls for a change in the existing strategic management paradigm with regard to the selection and implementation of strategic choices — from an environment-based approach only to a technology-based competency approach as well, and from an opportunity-seeking approach only to an opportunity-driven approach as well. The expanded framework serves as a basis for examining the specific linkages among FA technology, business strategy, and organizational structure. Superior performance will result when business strategy, both content and process, and organizational structure choices are congruent with the competencies and constraints of the firm's technological choice. Charts. Equations. References.

TITLE: A Comparison of Quality Attitudes in the USA and Japan: Empirical Evidence

AUTHORS: Reitsperger, Wolf D.; Daniel, Shirley J.

JOURNAL: Journal of Management Studies Vol: 28 Iss: 6 Date: Nov 1991 pp: 585-599 Jrnl Code: JMS ISSN: 0022-2380

TERMS: Studies; Factories; Work environment; Production controls; Quality control; Comparative analysis; Implications; U.S.; Japan

CODES: 5310 (Production planning & control); 5320 (Quality control); 9179 (Asia & the Pacific); 9190 (United States); 9130 (Experimental/theoretical)

ABSTRACT: Japanese successes in high-volume repetitive manufacturing have been largely attributed to a strategic focus on superior quality. Evidence is provided about the quality-cost trade-off philosophies in the U.S. and Japan, and the proposed differences between both countries are tested. The results of the test indicate that:

1. there are significant differences in quality philosophies between U.S. and Japanese operating managers,

2. there is a prevalence of "quality is free" philosophies among Japanese operating managers, but substantial proportions either disagree with "quality is free" notions or are undecided, and

3. larger proportions of U.S. than Japanese managers show attitudes reflecting a "quality is free" philosophy on all questions except the acceptance and delivery of below-specification components. Graphs. Charts. References.

Bibliography: Strategic Planning

TITLE: Dynamic Manufacturing: A Comparison of Attitudes in the U.S.A. and Japan

AUTHORS: Reitsperger, Wolf D.; Daniel, Shirley J.

JOURNAL: Management International Review (Germany) Vol: 30 Iss: 3 Date: Third Quarter 1990 pp: 203-216 Jrnl Code: MIR ISSN: 0025-181X

TERMS: U.S.; Japan; Manufacturing; Quality control; Upper management; Employee involvement; Policy making; Attitude surveys; Regression analysis; Comparative studies

CODES: 9190 (United States); 9179 (Asia & the Pacific); 8600 (Manufacturing industries); 9130 (Experimental/theoretical); 5320 (Quality control)

ABSTRACT: The prevalent notion is tested that, in Japan, dynamic evolution (DV) views are the conceptual base for operations policy making, while static optimization (SO) views are the model in the U.S. The data suggest that DV is now the prevalent model for policy making in the U.S. as well as in Japan. Of special significance is the finding that larger proportions of U.S. managers show attitudes reflecting DV than their Japanese counterparts. A DV-based quality-oriented learning process allows reductions of work-in-process inventory that are essential preconditions for greater flexibility in manufacturing and the associated implementation of the just-in-time concept. The findings suggest that U.S. manufacturing managers recognize the strategic importance of manufacturing. This is confirmed by the desire of a large proportion of U.S. manufacturing managers for top management policy making involvement in regard to the competitive dimensions of manufacturing strategy. Tables. References.

TITLE: A Method for Quality Precoordination in a Quality Assurance Information System

AUTHORS: Sylla, Cheickna; Arinze, Bay

JOURNAL: IEEE Transactions on Engineering Management Vol: 38 Iss: 3 Date: Aug 1991 pp: 245-256 Jrnl Code: IEE ISSN: 0018-9391

TERMS: Theory; Quality control; Information systems; Product development; Evaluation; Statistical analysis; Methods

CODES: 9130 (Experimental/theoretical); 7500 (Product planning & development); 5240 (Software & systems); 5320 (Quality control)

ABSTRACT: The concept of an information center for planning and controlling the quality of products and processes in a factory is introduced. This center is

called the Quality Assurance Information System (QAIS). Its role is to tie together such quality achievement-related functions as design, manufacturing, and other factory management systems to plan, optimize, and monitor overall computer-integrated manufacturing network performance. The quality functions of QAIS are viewed as carried out through coordination and precoordination activities. Precoordination aims at organizing the participation of all subsystems in the factory network in the planning of new product development and in providing methodologies for system evaluation and trade-off analysis for better solutions and integration. A formal approach for dealing with precoordination activities proposes a methodology for the quantitative evaluation and selection of appropriate complex systems. Diagrams. Equations. Graphs. Charts. Appendix. References.

TITLE: Buyer-Supplier Relations in the UK Automotive Industry: Strategic Implications of the Japanese Manufacturing Model

AUTHORS: Turnbull, Peter; Oliver, Nick; Wilkinson, Barry

JOURNAL: Strategic Management Journal Vol: 13 Iss: 2 Date: Feb 1992 pp: 159-168 Jrnl Code: SMJ ISSN: 0143-2095

TERMS: Buyers; Suppliers; Customer relations; Automobile industry; Just-in-time; Problems; Models; Comparative analysis; UK; Japan

CODES: 2400 (Public relations); 8303 (Wholesale industry); 9175 (Western Europe); 9179 (Asia & the Pacific); 8680 (Transportation equipment industry)

ABSTRACT: The adoption of the Japanese model of manufacturing in the UK motor industry is documented. Internal developments by the vehicle assemblers and their suppliers are examined. It is argued that the Japanese model involves very high intra- and interorganizational dependencies. Although this does not cause problems in Japan due to the structure of the Japanese motor industry, the structure of the UK vehicle industry presents severe obstacles to the successful use of Japanese methods. Pursuit of the pure Japanese model within the existing industry structure appears to be fraught with problems. Moreover, such an exercise risks sweeping away potential strengths of the existing structure. Charts. Diagrams. References.

Articles that Suggest Key Research Questions in Marketing and TQ

The annotated articles listed in the pages that follow were selected primarily because they suggest research topics appropriate for TQ. It was not our intention

Bibliography: Marketing and TQ

to evaluate these articles and these articles were not selected because of the quality of their research content. The list simply provides examples relating to important research questions and is not comprehensive.

TITLE: An Empirical Assessment of the SERVQUAL Scale

AUTHORS: Babakus, Emin; Boller, Gregory W.

JOURNAL: Journal of Business Research Vol: 24 Iss: 3 Date: May 1992 pp: 253-268 Jrnl Code: JBU ISSN: 0148-2963

TERMS: Quality of service; Measurement; Studies; Statistical analysis; Correlations

CODES: 5320 (Quality control); 9130 (Experimental/theoretical)

ABSTRACT: A comprehensive measurement instrument, known as SERVQUAL, has been developed to measure perceived service quality. The definition and measurement of service quality as a 5-dimensional construct, as in SERVQUAL, appears to suffer from a number of methodological shortcomings. The findings of a recent study suggest that the dimensionality of service quality may depend on the type of services under study. The use of mixed-item wording and the current operationalization of service quality on the basis of gap scores appear to be 2 major problems in the measurement of the construct. Researchers in the process of using SERVQUAL should exercise caution. It may not be fruitful to pursue the development of a standard measurement scale applicable to a wide variety of services. The domain of service quality may be factorially complex in some industries and very simple and unidimensional in others. As such, measures designed for specific service industries may be a more viable research strategy to pursue. References. Charts.

TITLE: Evaluating Service Encounters: The Effects of Physical Surroundings and Employee Responses

AUTHORS: Bitner, Mary Jo

JOURNAL: Jrnl of Marketing Vol: 54 Iss: 2 Date: Apr 1990 pp: 69-82 Jrnl Code: JMK ISSN: 0022-2429

TERMS: Customer services; Customer relations; Satisfaction; Marketing mixes; Theory; Studies; Variables

CODES: 2400 (Public relations); 9130 (Experimental/theoretical)

ABSTRACT: A model for understanding service encounter assessment that synthesizes consumer satisfaction, services marketing, and attribution theories

Bibliography: Marketing and TQ

is presented. A controlled experiment to test a part of the model is conducted to assess the effects of physical surroundings and employee responses on attributions and satisfaction in a service failure context. The subjects are 145 travelers at an international airport who read a story involving a travel agency and responded to measures of disconfirmation, attributions, attitude, satisfaction, and intended behaviors. The results of the experiment indicate that:

1. it is important to manage and control every individual service encounter to increase overall perceptions of service quality,

2. when the experience is not what the customer expects, there may be a chance to turn the encounter into a more satisfying one by understanding the customer's attribution processes, and

3. providing customers with logical explanations for service failures and compensating them in some way can mitigate dissatisfaction. Tables. Charts. References.

TITLE: A Longitudinal Analysis of the Impact of Service Changes on Customer Attitudes

AUTHORS: Bolton, Ruth N.; Drew, James H.

JOURNAL: Jrnl of Marketing Vol: 55 Iss: 1 Date: Jan 1991 pp: 1-9 Jrnl Code: JMK ISSN: 0022-2429

COMPANY: GTE Corp (DUNS: 00-129-3950)

TERMS: Customer services; Customer satisfaction; Consumer attitudes; Mathematical models; Experiments; U.S.

CODES: 7100 (Market research); 9190 (United States)

ABSTRACT: A longitudinal model of the effect of a service change on customer attitudes about service quality is developed and estimated with data from a field experiment with 3 survey waves. The field experiment was conducted as part of GTE Laboratories Inc.'s customer satisfaction program and was devised to test the effect of a network upgrade program on residential customers' ratings. The interview procedure yielded 119 respondents who completed the interview for all 3 waves. Service changes were found to have a strong influence on customer assessments of service quality. The changes affected customer perceptions of present performance and disconfirmation. As expected, attitudes are affected strongly by current performance ratings and, to a lesser extent, by disconfirmation. The effect of disconfirmation is

Bibliography: Marketing and TQ

larger, and the effect of previous attitudes is smaller, directly after the service change than in a subsequent time period. Tables. Equations. References.

TITLE: A Multistage Model of Customers' Assessments of Service Quality and Value

AUTHORS: Bolton, Ruth N.; Drew, James H.

JOURNAL: Jrnl of Consumer Research Vol: 17 Iss: 4 Date: Mar 1991 pp: 375-384 Jrnl Code: JCR ISSN: 0093-5301

TERMS: Consumer behavior; Expectations; Telephone service; Market research; Customer satisfaction; Statistical analysis; Studies

CODES: 7100 (Market research); 9130 (Experimental/theoretical)

ABSTRACT: The constructs of customer satisfaction, perceived service quality, and service value were integrated in a multistage model of residential customers' perceptions of performance, quality, and value for local telephone service. The model was operationalized as a multiple-equation system and estimated by a 2-stage least squares procedure, with data taken from customer surveys of 1,408 residential telephone subscribers in 1985. Results indicate that residential customers' assessments of quality and value are mainly a function of disconfirmation arising from discrepancies between anticipated and perceived performance levels. However, perceived performance levels also were found to have an important direct effect on quality and value assessments. Results for the billing, local, and long equations were remarkably similar. In the residential mode, the primary determinants of overall telephone service quality were the billing, local, and long variables. The most important determinant of perceived service value was quality. Charts. Equations. References.

TITLE: A Service Quality Process Map for Credit Card Processing

AUTHORS: Collier, David A.

JOURNAL: Decision Sciences Vol: 22 Iss: 2 Date: Spring 1991 pp: 406-420 Jrnl Code: DSI ISSN: 0011-7315

TERMS: Decision support systems; Credit cards; Customer services; Quality control; Operations research; Mathematical models; Statistical analysis; Studies; Financial services

CODES: 2600 (Management science/operations research); 5240 (Software & systems); 9130 (Experimental/theoretical); 2400 (Public relations); 8100 (Financial services industry)

Bibliography: Marketing and TQ

ABSTRACT: The customer's evaluation of service quality is quantitatively related directly to the activities and performance criteria of the service delivery process for a credit card processing center. Basic statistical analyses and a recursive path analysis model define the relationships between marketing-based and operations-based service quality information. A service quality process map is introduced that relates a flowchart of the service delivery process to the customer's perception of service using multivariate data analysis. The service quality process maps coordinate the marketing and operations functions. Management insights gained from an analysis of marketing and operations measures of service quality performance can be used for the efficient allocation of resources. Charts. Equations. References.

TITLE: Marketing's Role in Product and Service Quality

AUTHORS: Cravens, David W.; Holland, Charles W.; Lamb, Charles W., Jr.; Moncrief, William C., III

JOURNAL: Industrial Marketing Mgmt Vol: 17 Iss: 4 Date: Nov 1988 pp: 285-304 Jrnl Code: IMM ISSN: 0019-8501

TERMS: Marketing; Quality; Measurement; Customer services; Improvements; Processes

CODES: 7000 (Marketing); 5320 (Quality control)

ABSTRACT: Superior product quality is one of the most important strategic priorities facing business today. Since defining and measuring quality can be complicated, Garvin (1984) offers 5 approaches:

1. transcendent,
2. product-based,
3. user-based,
4. manufacturing-based, and
5. value-based.

Regarding quality assurance, management must focus on determining customer quality expectations, applying the quality process to improve marketing operations quality, and using product and supporting service quality to gain marketing advantage. The application of quality improvement to marketing involves the following steps:

1. institutionalizing the quality improvement philosophy,
2. defining the relevant marketing processes,
3. selecting quality measures to be tracked,

Bibliography: Marketing and TQ

4. statistically stabilizing the process, and

5. improving the process. Strategy integration is a critical implementation issue in marketing. Another important issue involves recognizing the crucial role of market targeting in quality improvement. Tables. Graphs. Diagrams. References.

TITLE: A Gap Analysis of Professional Service Quality

AUTHORS: Brown, Stephen W.; Swartz, Teresa A.

JOURNAL: Jrnl of Marketing Vol: 53 Iss: 2 Date: Apr 1989 pp: 92-98 Jrnl Code: JMK ISSN: 0022-2429

TERMS: Professional practice; Perceptions; Quality; Statistical analysis; Physicians; Patients

CODES: 7100 (Market research); 8320 (Health care industry); 9130 (Experimental/theoretical)

ABSTRACT: Providers of professional services are beginning to understand more about consumer challenges, competition, and marketing realities. With these changes, a related and equally important issue has emerged, that of service quality and the evaluation of the service encounter. Using medical services as the primary study setting, the concept of professional services quality and its evaluation is examined from both provider and client perspectives. Gap analysis is used to examine the evaluation of a professional service. The findings provide empirical insight into the gaps that can arise from inconsistent perceptions of expectations and experiences between patients and physicians. Once inconsistencies are identified, strategies and tactics for achieving more consistent expectations and experiences can be initiated. Compatible expectations and experiences can be achieved by altering the provider's expectations and experiences or altering the client's expectations and experiences. Tables. Equations. References.

TITLE: Patterns of Communications Among Marketing, Engineering and Manufacturing - A Comparison Between Two New Product Teams

AUTHORS: Griffin, Abbie; Hauser, John R.

JOURNAL: Management Science Vol: 38 Iss: 3 Date: Mar 1992 pp: 360-373 Jrnl Code: MCI ISSN: 0025-1909

TERMS: Product development; Quality control; Group dynamics; Theory; Studies; U.S.; Japan

Bibliography: Marketing and TQ

CODES: 7500 (Product planning & development); 9190 (United States); 9179 (Asia & the Pacific); 9130 (Experimental/theoretical); 2500 (Organizational behavior)

ABSTRACT: Models and scientific evidence suggest that firms are more successful at new-product development if there is greater communication among marketing, engineering and manufacturing. Communication patterns for 2 matched product-development teams are examined where the key difference between the groups is that one used a phase-review development process and the other used Quality Function Deployment (QFD). The data suggest that QFD enhances communication levels within the core team. QFD changes communication patterns from "up-over-down" flows through management to more horizontal routes where core team members communicate directly with one another. On the other hand, the QFD team communicates less on planning information and less with members of the firm external to the team. If this paucity of external communication means that the team has the information it needs for product development, and the QFD process has provided an effective means for moving the information through the team, it is a positive impact of QFD. References. Diagrams. Charts. Graphs.

TITLE: Marketing-Orientation Revisited: The Crucial Role of the Part-Time Marketer

AUTHORS: Gummesson, Evert

JOURNAL: European Journal of Marketing Vol: 25 Iss: 2 Date: 1991 pp: 60-75 Jrnl Code: EJM ISSN: 0309-0566

TERMS: Marketing management; Theory; Internal; Customer relations; Customer satisfaction; Roles; Total quality

CODES: 2400 (Public relations); 7000 (Marketing); 9130 (Experimental/theoretical); 5320 (Quality control)

ABSTRACT: Part-time marketers are those who conduct marketing activities but do not belong to the marketing or sales department. Marketing activities are carried out by all employees and all others who influence an organization's customer relations directly or indirectly. Recruitment and training must be geared toward the fact that companies need both part-time and full-time marketers. The influence of so many people on customers creates multiple marketing opportunities. Instead of viewing the marketing department as the

Bibliography: Marketing and TQ

apex of marketing activities, it may be seen as a supplement to points of marketing, providing overall strategies and resources. Through the concepts of internal customer and process management, total quality management (TQM) has become an integrator between production orientation and marketing orientation and between technology-driven and market-driven behavior. Diagrams. References.

TITLE: Market-Oriented Product Innovation at Hoyang Polaris and Jotul

AUTHORS: Holt, Knut

JOURNAL: Technovation (Netherlands) Vol: 8 Iss: 4 Date: Dec 1988 pp: 249-254 Jrnl Code: TCH ISSN: 0166-4972

TERMS: Needs analysis; Assessments; Market orientation; Product development; Studies; Norway

CODES: 7500 (Product planning & development); 9175 (Western Europe)

ABSTRACT: (This is a correction of record number 89-16097.) In theory, marketing starts with the market. It is important to understand:

1. the users,
2. their problems, and
3. their needs.

Market orientation requires a determined effort and a systematic approach to learn what the problems and the needs of the users are. This type of product innovation was used at 2 industrial companies — Hoyang Polaris and Jotul. A study of their market-oriented product innovation permits the development of a basic model for the design of a need assessment system. Its parameters include:

1. originator,
2. company size,
3. type of market,
4. technology strategy,
5. environment,
6. management attitude, and
7. user sector structure.

This model may be modified with additional parameters. The most important parameters influencing the organization of need assessment activities are management attitude and company size. Numerous other methods are available for need assessment purposes. Diagrams. Tables. Charts.

Bibliography: Marketing and TQ

TITLE: Consumer Multiattribute Judgments Under Attribute-Weight Uncertainty

AUTHORS: Kahn, Barbara E.; Meyer, Robert J.

JOURNAL: Jrnl of Consumer Research Vol: 17 Iss: 4 Date: Mar 1991 pp: 508-522 Jrnl Code: JCR ISSN: 0093-5301

TERMS: Market research; Mathematical models; Uncertainty; Customer buying behavior; Theory; Experiments; Studies; Effects; Statistical analysis

CODES: 7100 (Market research); 9130 (Experimental/theoretical)

ABSTRACT: A study examines how multi-attribute impressions are formed in riskless choice and judgment when there is uncertainty or ambiguity associated with attribute-importance weights. Building on previous results in the modeling of ambiguity in probabilities, a mathematical theory of multiattribute judgments under weight uncertainty incorporates framing effects for ambiguous weights in multi-attribute judgments. Specifically, it is shown that the importance of an attribute depends on whether it is seen as enhancing or preserving an expected level of utility in a category. The results of 3 experiments lend support to the predicted dependency of the effects of weight uncertainty on an attribute's framing. The data suggest that, within frames, the effects of increasing uncertainty may not be additive across attributes. In particular, given pairs of uncertain attributes with different frames, subjects acted as if they were applying a single frame to both attributes, resulting in a common direction for the weight-uncertainty effect. Charts. Graphs. Equations. References.

TITLE: After Sales Service Quality: Views Between Industrial Customers and Service Managers

AUTHORS: Kasper, Hans; Lemmink, Jos

JOURNAL: Industrial Marketing Mgmt Vol: 18 Iss: 3 Date: Aug 1989 pp: 199-208 Jrnl Code: IMM ISSN: 0019-8501

TERMS: Industrial markets; Customer services; Quality; Market research; Sales

CODES: 7100 (Market research); 8303 (Wholesale industry); 7300 (Sales & selling)

ABSTRACT: The concept of service is attracting more attention in the marketing literature. A study focused on the possible discrepancy between the industrial customers' perceived after sales service quality and the management's perception of their industrial customers' perceived after sales service quality. The customers of the company examined were private firms and public organizations. A questionnaire was developed in which various issues were

Bibliography: Marketing and TQ

raised about the supplier-company as well as about the after sales services rendered. Questionnaires were completed by 525 industrial customers of the firm and by 25 of the firm's service managers. The results indicate that the service managers' perception of the industrial customers' perceived after sales service quality differs from the customers' perceived after sales service quality. With regard to the quality of almost all aspects of the service rendered, service managers believe the customers will be less satisfied than they actually are. Tables. Graphs. References.

TITLE: How to Measure Industrial Service Quality

AUTHORS: Kierl, Charles; Mitchell, Paul

JOURNAL: Industrial Marketing Digest (UK) Vol: 15 Iss: 1 Date: First Quarter 1990 pp: 35-46 Jrnl Code: IMD ISSN: 0950-9038

TERMS: Customer services; Quality; Measurement; Characteristics; Stages; Marketing; Studies

CODES: 5320 (Quality control); 7000 (Marketing)

ABSTRACT: SERVQUAL is a recent attempt by academics in the U.S. to provide a methodology for measuring customer service quality. This approach was applied to the services of a sample of major UK chemical suppliers. Nine of SERVQUAL's dimensions of service quality were used to develop a questionnaire on service quality. An attempt was made to measure the perceptions of customers as to the current level of service provided and the extent to which future potential existed for service improvement. Personal interviews were conducted with 85 senior purchasing managers. An equation of the gap between ideal and perceived scores was used to assess the degree of customer satisfaction-quality of service. Communication had the largest gap, followed by customer needs, indicating that these are the issues in which customers are least satisfied. Using joint-space, multidimensional scaling, companies and statements were clustered in the areas describing overall competence-skill and customer needs. Tables. Graphs. References. Charts.

TITLE: Defining and Measuring the Quality of Customer Service

AUTHORS: Lewis, Barbara R.; Mitchell, Vincent W.

JOURNAL: Marketing Intelligence & Planning (UK) Vol: 8 Iss: 6 Date: 1990 pp: 11-17 Jrnl Code: MIP ISSN: 0263-4503

TERMS: Customer services; Quality of service; Customer satisfaction; Improvements; Methods; Measurement; Expectations

Bibliography: Marketing and TQ

CODES: 2400 (Public relations)

ABSTRACT: The role of service quality as an indicator of customer satisfaction and organizational performance is now widely acknowledged. Many suggested definitions of service quality focus on meeting customer needs and requirements. Parasuraman, Zeithaml, and Berry (1988) developed SERVQUAL, a concise multiple-item scale that can be used to understand better service expectations and consumer perceptions. It can be used to look at trends over time or compare branches or outlets within an organization. A firm's customers can be categorized into several perceived-quality segments on the basis of their individual SERVQUAL scores. Problems with SERVQUAL include:

1. the treatment of all items in the scale as equally important,
2. half of the statement being negatively worded,
3. the restriction of consumers' responses to a 7-point scale, and
4. the adjectives used in SERVQUAL statements.

Researchers might consider the use of a bipolar semantic differential graphic scale to overcome the problems highlighted with the SERVQUAL measurement tool. Equations. References.

TITLE: Vital Cross-Functional Linkages with Marketing

AUTHORS: Lim, Jeen-Su; Reid, David A.

JOURNAL: Industrial Marketing Management Vol: 21 Iss: 2 Date: May 1992 pp: 159-165 Jrnl Code: IMM ISSN: 0019-8501

COMPANY: Avco Corp (DUNS: 00-136-7903)

TERMS: Marketing; Relations; Functions; Integration; Organizational structure; Models; Implementations; Guidelines; Studies

CODES: 9130 (Experimental/theoretical); 7000 (Marketing); 2320 (Organizational structure); 9150 (Guidelines)

ABSTRACT: The linkages between marketing and other functional areas of a business remain relatively unexplored despite their importance. A 9-step integrated framework is developed that explicitly considers the impact of managing cross-functional linkages within the firm on marketing and other function's plans. The first 3 steps involve a traditional assessment of the marketing opportunity analysis and planning process suggested by Wind and Robertson (1983). Steps 4 through 9 focus on developing and implementing an integrative cross-functional perspective. The framework promotes more

Bibliography: Marketing and TQ

effective and efficient use of resources to achieve the firm's overall objectives, which may provide distinct competitive advantages for the firm. Bringing about the shift to an integrative cross-functional perspective requires a number of organizational changes. At a minimum, top management must make a strong commitment to ensure high-quality interdepartmental working relationships. Charts. References.

TITLE: Market-Led Quality

AUTHORS: Morgan, Neil A.; Piercy, Nigel F.

JOURNAL: Industrial Marketing Management Vol: 21 Iss: 2 Date: May 1992 pp: 111-118 Jrnl Code: IMM ISSN: 0019-8501

TERMS: Quality; Consumer attitudes; Perceptions; Market strategy; Implications; Studies; Recommendations

CODES: 9130 (Experimental/theoretical); 5320 (Quality control); 7100 (Market research)

ABSTRACT: The focus of the management of quality consists of 3 main pillars:

1. customer focus,
2. process understanding, and
3. people involvement.

The holistic model of quality explicitly recognizes that customer quality perceptions are a product of the difference between initial customer expectations and their perceptions of the outcomes achieved in buying a product or service. The holistic model also recognizes that customers evaluate at least 2 dimensions of quality — technical quality and functional quality — and that customer perceptions of technical and functional quality of products and services can be affected by their image of the supplier organizations. The holistic approach to quality may offer marketers an alternative mechanism for achieving a market orientation within their organizations. The holistic management of quality may increase connectedness and reduce conflict between marketing and engineering, production, and manufacturing. Charts. References.

TITLE: An Analysis of Needs Assessment and Information Behaviour in Product Development Based on the Fusion Model

AUTHORS: Muramatsu, Rintaro; Ichimura, Takaya; Ishii, Kazuyoshi

JOURNAL: Technovation (Netherlands) Vol: 10 Iss: 5 Date: Jul 1990 pp: 305-315 Jrnl Code: TCH ISSN: 0166-4972

Bibliography: Marketing and TQ

TERMS: Needs analysis; Product development; Models; Methods; Requirements; Users; Innovations; Characteristics; Theory

CODES: 7500 (Product planning & development); 9130 (Experimental/theoretical)

ABSTRACT: A model is proposed and analytical methods are developed for designing and improving an effective management system for new product development. The model represents the processes of new product development from users' needs assessment to the manufacturing stage under a policy, and the methods analyze the information behavior and idea generation in the processes. The model, which is called the fusion model, stresses the fusion of users' needs assessment with technology assessment. The effectiveness of the model and methods proposed is shown through the applied case of a futon drying machine. The policy to develop a new product was changed as a result of needs assessment and idea generation. The relationships among the purpose of idea generation, method of information gathering, and important information in the development process of a new product is clarified, and the problem of information behavior can be defined for the further improvement of the product. Tables. Charts. Diagrams. References.

TITLE: New Product Planning at Hitachi

AUTHORS: Nishikawa, Toru

JOURNAL: Long Range Planning (UK) Vol: 22 Iss: 4 Date: Aug 1989 pp: 20-24 Jrnl Code: LRP ISSN: 0024-6301

Company: Hitachi Ltd (DUNS: 69-054-1503)

TERMS: Case studies; Market research; Consumer behavior; Appliances; Appliance industry; Advertising; Product development; Market planning

CODES: 9110 (Company specific); 7100 (Market research); 8670 (Machinery industry)

ABSTRACT: Hitachi Ltd. (Japan) introduced a quiet washing machine in 1987. This was the result of continuous market research, which revealed a remarkable change in habitual washing times. As working women began to outnumber those staying at home, washing times were shifting from daytime to night and early morning. Housewives who wash clothes at night or in the early morning worry mostly about noise. The factors that are important for successful new product planning are:

Bibliography: Marketing and TQ

1. understanding the changes in consumers' lifestyles,
2. observing trends that are occurring,
3. determining the necessary target market by experiment or real-life experience, and
4. creating an idea that will appeal to customers.

There are 5 obstacles that may hide the truth in consumer research as part of planning for a new product. The problems arise from:

1. indifference,
2. absence of responsibility,
3. conservative attitudes,
4. vanity, and
5. ignorance.

A new framework of marketing methods and strategies must be built. Charts. References.

TITLE: Marketing's Lead Role in Total Quality

AUTHORS: O'Neal, Charles R.; LaFief, William C.

JOURNAL: Industrial Marketing Management Vol: 21 Iss: 2 Date: May 1992 pp: 133-143 Jrnl Code: IMM ISSN: 0019-8501

COMPANY: Ford Motor Co (DUNS: 00-134-4746), Motorola Inc (DUNS: 00-132-5463), Blount Inc (DUNS: 05-863-8040), Mitsubishi Heavy Industries Ltd (DUNS: 69-054-3756), Digital Equipment Corp (DUNS: 00-103-8066)

TERMS: Total quality; Industrial markets; Customer satisfaction; Product differentiation; Market strategy; Many companies; Studies; U.S.

CODES: 9190 (United States); 9130 (Experimental/theoretical); 7000 (Marketing); 5320 (Quality control)

ABSTRACT: Many industrial firms' lack of success in achieving customer satisfaction and profitability may be attributed to their continued orientation to the sales-buying concept. The marketing concept is an appropriate strategy and the adoption of the total quality concept is critical to its successful application. The quality function deployment (QFD) process is a mechanism for determining exchange partner requirements and assuring conformance to those requirements. It is suggested that the marketing function take a leadership role in administering the process. The outcome of the QFD process is product differentiation, which allows higher prices, increased market share, and lower costs — all of which lead to higher profitability. The QFD process

provides a comprehensive, customer-focused methodology to establish customer needs, specify the means of satisfying these needs, and facilitate the use of appropriate quality technologies in the transformation and delivery processes. Charts. References.

TITLE: Measuring Customer Satisfaction: Fact and Artifact

AUTHORS: Peterson, Robert A.; Wilson, William R.

JOURNAL: Journal of the Academy of Marketing Science Vol: 20 Iss: 1 Date: Winter 1992 pp: 61-71 Jrnl Code: AMK ISSN: 0092-0703

TERMS: Customer satisfaction; Measures; Market research; Factors; Statistical analysis

CODES: 9130 (Experimental/theoretical); 7100 (Market research)

ABSTRACT: Self-reports of customer satisfaction invariably possess distributions that are negatively skewed and exhibit a positivity bias. Methodologically related explanations for this include:

1. a ceiling effect,
2. response rate bias,
3. data collection mode bias,
4. question form,
5. question context,
6. measurement timing, and
7. response styles.

There are indications that higher levels of satisfaction are obtained when personal or telephone interviews are used than when mail or self-administered interviews are used. Research indicates a need for caution when interpreting answers to satisfaction questions. Mood also influences satisfaction ratings. It is concluded that measurements of customer satisfaction are context-dependent. Unless viable unobtrusive measuring devices become available, it is probably impossible to measure true satisfaction. Charts. Graphs. References.

TITLE: Identify and Fulfill Customer Service Expectations

AUTHORS: Powers, Thomas L.

JOURNAL: Industrial Marketing Mgmt Vol: 17 Iss: 4 Date: Nov 1988 pp: 273-276 Jrnl Code: IMM ISSN: 0019-8501

TERMS: Customer services; Customer relations; Marketing; Quality; Industrial goods

Bibliography: Marketing and TQ

CODES: 7000 (Marketing); 5320 (Quality control)

ABSTRACT: One of the most difficult challenges for industrial marketers is the ability to identify what the customer wants and then develop programs to deliver the desired level of service. Several areas of service quality can be used as guidelines in the process. The time dimension of quality includes:

1. search qualities, which the customer can perceive prior to the purchase,
2. experience quality, which is based on a post-purchase evaluation of the product, and
3. credence quality, which is involved with the overall credibility of the product offer.

Another area of service quality focuses on the difference between tangible qualities — which the customer can see — and intangible qualities such as reliability, responsiveness, assurance on the part of employees, and empathy by the firm for customers. Industrial marketers can improve quality by:

1. determining customer expectation level through market research,
2. learning customer perceptions of service level, and
3. taking action. Tables. Charts. References.

TITLE: Putting Consumer Experience Back into Consumer Research: The Philosophy and Method of Existential-Phenomenology

AUTHORS: Thompson, Craig J.; Locander, William B.; Pollio, Howard R.

JOURNAL: Jrnl of Consumer Research Vol: 16 Iss: 2 Date: Sep 1989 pp: 133-146 Jrnl Code: JCR ISSN: 0093-5301

TERMS: Consumer; Research; Methods; Interviews

CODES: 7100 (Market research)

ABSTRACT: Existential-phenomenology is an alternative paradigm for conceptualizing and studying consumer experience. The method employs a "something different" hypothesis: Experience is something different than response patterns or cognitive structures. As such, existential-phenomenology offers a philosophical base from which to explore consumer experience in nondualistic terms. It seeks to develop and employee methods that allow for a first-person description of lived experience. The world of lived experience does not always correspond with the world of objective description. This is because objectivity often implies trying to explain an event as separate from its contextual setting. In both philosophy

and method, existential-phenomenology provides a means for putting consumer experience back into consumer research. Tables. References.

TITLE: Influences upon Consumer Expectations of Services

AUTHORS: Webster, Cynthia

JOURNAL: Jrnl of Services Marketing Vol: 5 Iss: 1 Date: Winter 1991 pp: 5-17 Jrnl Code: JSV ISSN: 0887-6045

TERMS: Customer services; Customer satisfaction; Marketing; Consumer behavior; Word of mouth advertising; Quality; Studies

CODES: 9130 (Experimental/theoretical); 8300 (Other services); 7200 (Advertising)

ABSTRACT: An examination of the possible influences on consumer expectations of quality and how those expectations might be better met provides insight into the concept of quality in the service market. Four sources of information — past personal experience, opinion leadership, advertising, and sales promotion — were manipulated in order to determine their impact on consumers' expectations toward 6 professional and nonprofessional services: medical, legal, dental, auto-related, laundry, and travel. Significant differences were found in the nature of expectations as the stimuli were varied. These differences remained even after involvement and personal need effects were removed. Findings indicate that expected services, which is a critical component of perceived service quality, is significantly influenced by the 4 sources of information. Overall, word of mouth communications had the strongest impact on expectations, followed by past personal experience, advertising, and sales promotion. Appendix. References.

TITLE: The Dimensionality of Consumption Emotion Patterns and Consumer Satisfaction

AUTHORS: Westbrook, Robert A.; Oliver, Richard L.

JOURNAL: Journal of Consumer Research Vol: 18 Iss: 1 Date: Jun 1991 pp: 84-91 Jrnl Code: JCR ISSN: 0093-5301

TERMS: Emotions; Satisfaction; Pattern; Consumer attitudes; Market research; Cluster analysis; Comparative studies; Consumer behavior

CODES: 7100 (Market research); 9130 (Experimental/theoretical)

ABSTRACT: The interrelationships between consumption emotion and satisfaction judgments are examined using taxonomic and dimensional analyses to identify patterns of emotional response to product experiences. A

judgmental area sample of owners of newly purchased automobiles is used to examine naturally occurring emotional responses within the consumer population. Five identifiable patterns of effective experience are evident:

1. happy-content,
2. pleasant surprise,
3. unemotional,
4. unpleasant surprise, and
5. angry-upset.

The patterns are based on 3 independent effective dimensions of hostility, pleasant surprise, and interest. The results extend prior findings of a simple bidimensional effective-response space and reveal that satisfaction measures vary in their ability to represent the effective content of consumption experiences. Charts. References.

TITLE: Profitability: The Payoff for Good Service

AUTHORS: Anonymous

JOURNAL: Traffic Management Vol: 30 Iss: 6 Date: Jun 1991 pp: 47-50 Jrnl Code: TM ISSN: 0041-0691

TERMS: Customer services; Complaints; Profitability; Quality control; Logistics; Problems; U.S.

CODES: 5160 (Transportation management); 5320 (Quality control); 9190 (United States)

ABSTRACT: The linkage between customer service and profitability is a demonstrable fact, according to Harvey N. Shycon, a director with the consulting company of Arthur D. Little Inc. (Cambridge, Massachusetts). Before joining Little, Shycon operated his own logistics consulting company for many years and was among the early proponents of customer service. Shycon has found that, by providing the right level of customer service, a company can actually improve profitability and market share by as much as 10%. While it is clear that the customer's perspective is the important one, it is less evident how customers form opinions on service. Shycon's studies indicate that the customer sees service as part of a total package comprised of the product, the service that comes with the product, and the value. Shycon has identified a list of more than 50 service factors that confirm the premise that logistics plays a central role in customer service. Graphs.

Research Issues in Statistical Methods: Process Control — A Long Tradition of Research

WALTER A. SHEWHART (1931)

Economic Control of Quality of Manufactured Product, Van Nostrand, N.Y. (reprinted by the American Society for Quality Control 1981).

COMMENT: This work defines the process control and capability problem introduces the fundamental concepts of assignable (special) and non assignable (common) causes of variation and introduces the statistical control chart as a solution to the problem. At once both deeply philosophical and practical it is still relevant today.

M. A. GIRSHICK AND H. RUBIN (1952)

A Bayes Approach to a Quality Control Model," *Annuals of Mathematical Statistics* 23, 114-125.

COMMENT: This the first attempt by pure theoreticians to put the Shewhart model and problem on a sound theoretical basis. The paper contains an interesting and illuminating model but no implementable solution.

ACHESON J. DUNCAN (1956)

"The economic design of $\bar{X}$ charts used to maintain current control of a process." *J. of the American Statistical Association* 51, 228-242.

COMMENT: This paper provides a practical model of the economic tradeoffs involved in choosing sampling frequencies and control limit settings for monitoring an ongoing process that has already been brought into a state of statistical control (stability) but occasionally is upset from that condition. An approximate solution method is offered. This truly seminal paper started a stream of research that continues to this day. See the Gibra and Montgomery bibliographies that were cited earlier for detailed references. Unfortunately, too much of this subsequent research appears to have been conducted without any reference to actual problems.

J. STUART HUNTER (1986)

"The Exponentially Weighted Moving Average," *J. of Quality Technology*, 18 (4) 203-209.

COMMENT: This paper picks up on a theme proposed earlier by Roberts that more complex statistics than the simple subgroup arithmetic averages proposed by Shewhart can be used for process control. The methods are very similar in spirit to the "cumulative sum control charts" proposed by the

Bibliography: Statistical Methods

Englishmen E. S. Page (1954) and G. A. Barnard (1959). The paper is an entry point to a modern stream of research that is examining a set of theoretical and implementation issues concerning the relative merits of the exponentially weighted moving average, the cumulative sum and their progeny, and the deterministic differential equations approach to process control frequently employed by process engineers. Some examples of recent research in the area of process control can be found in the following papers.

T. J. LORENTZEN AND L. C. VANCE (1986)

"The Economic Design of Control Charts: A Unified Approach," *Technometrics*, 28.

E. M. SANIGA (1989)

"Economic Statistical Control Chart Design with an Application to $\bar{X}$ and R Charts," *Technometrics*, 31.

J. M. LUCAS AND M. S. SACCUCCI (1990)

"Exponentially Weighted Moving Average Control Schemes: Properties and Enhancements," *Technometrics*, 32.

Abstract and Comments on some very recent papers follow:

S. V. CROWDER (1992)

"An SPC Model for Short Production Runs: Minimizing Expected Cost," *Technometrics*, 34, 64-73.

ABSTRACT: In some manufacturing situations, the assumption of a long production run may not be appropriate. For example, job shops typically will not have the benefit of large production runs. Much of the literature on the economic design of control charts, however, assumes an effectively infinite production run. A finite-horizon or short-production-run version of an economic-process-control model of Bather and Box and Jenkins is considered here. An algorithm is derived that allows implementation of this model and adjustment strategy for the short-production-run case. The solution to the control problem is consistent with traditional statistical process control philosophy in that process adjustment is call for only when the process mean is substantially off target. The control or adjustment limits for this model are time-varying and depend on the break-even points between quadratic cost for being off target and fixed adjustment cost. It is shown that the length of the production run can greatly influence the control or adjustment strategy. Use

of control limits based on the assumption of an infinite-run process can significantly increase total expected cost.

N. F. FARNUM (1992)

"Control Charts for Short Runs: Nonconstant Process and Measurement Error," *J. of Quality Technology*, 24, 138-144.

ABSTRACT: When the usual assumption of constant variances does not hold, the recommended substitute for a deviations from nominal (DNOM) chart is to chart standardized deviations. This has the added difficulty of estimating different standard deviations for each subgroup. As an alternative to this, an approach to DNOM charts that allows more general process and measurement error models is presented. When applied to the constant variance case, the usual chart of differences from nominal results. When applied to the constant coefficient of variation case, a new DNOM chart based on ratios of subgroup means to nominals results. Both charts have the desirable feature of constant control limits.

C. A. LOWERY, W. H. WOODALL, C. W. CHAMP AND S. E. RIGDON (1992)

"A Multivariate Exponentially Weighted Moving Average Control Chart," *Technometrics*, 34, 46-53.

ABSTRACT: A multivariate extension of the exponentially weighted moving average (EWMA) control chart is presented, and guidelines given for designing this easy-to-implement multivariate procedure. A comparison shows that the average run length (ARL) performance of this chart is similar to that of multivariate cumulative sum (CUSUM) control charts in detecting a shift in the mean vector of a multivariate normal distribution. As with the Hotelling's X^2 and multivariate CUSUM charts, the ARL performance of the multivariate EWMA chart depends on the underlying mean vector and covariance matrix only through the value of the noncentrality parameter. Worst-case scenarios show that Hotelling's X^2 charts should always be used in conjunction with multivariate CUSUM and EWMA charts to avoid potential inertia problems. Examples are given to illustrate the use of the proposed procedure.

S. V. CROWDER AND M. D. HAMILTON

"An EWMA for Monitoring a Process Standard Deviation," *J of Quality Technology*, 24, 12-21.

Bibliography: Statistical Methods

ABSTRACT: Most applications of the exponentially weighted moving average (EWMA) for process monitoring have concentrated on the problem of detecting shifts in the mean level of a process. Perhaps more important is the problem of detecting increases in process variability, which can also have a major impact on product quality. In this paper we propose using an EWMA based on the log transformation of the sample variance. Properties of this EWMA are given and an optimal design strategy is presented. It is shown that the EWMA is superior to the usual range chart of s^2 chart in terms of its ability to quickly detect small increases in the standard deviation of a normal process.

N. D. TRACY, J. C. YOUNG AND R. L. MASON, (1992)

"Multivariate Control Charts for Individual Observations," *J. of Quality Technology*, 24, 88-95.

ABSTRACT: When p correlated process characteristics are being measured simultaneously, often individual observations are initially collected. The process data are monitored and special causes of variation are identified in order to establish control and to obtain a "clean" reference sample to use as a basis in determining the control limits for future observations. One common method of constructing multivariate control charts is based on Hotelling's T^2 statistic. Currently, when a process is in the start-up stage and only individual observations are available, approximate F and chi-square distributions are used to construct the necessary multivariate control limits. These approximations are conservative in this situation. This article presents an exact method, based on the beta distribution, for constructing multivariate control limits at the start-up stage. An example from the chemical industry illustrates that this procedure is an improvement over the approximate techniques, especially when the number of subgroups is small.

K. LIGHTBURN AND B. G. DALE (1992)

"A Critique of Statistical Process Control in a First-Line Motor Industry Supplier," *Quality Engineering*, 4, 371-382.

ABSTRACT: A case study of statistical process control (SPC) in a first-line component supplier to the motor industry is reported. Particular emphasis is given to the shortcomings of the company's application of SPC. The main findings, include the identification of a number of flaws in the control charting with a mix of different philosophies in use, the company had not followed any

formal SPC implementation plan, the initial SPC training carried out on behalf of the company was based on outdated principles, and it proved difficult to change some of the first-line supervisors' views on control charting as a result of this early training. There was lack of reactive disciplines and corrective action. It is also pointed out that many of the difficulties emanated from a lack of senior and middle management commitment and leadership to SPC and the company had use a series of camouflage measures to hide the situation from their customers.

J. J. DAUDIN (1992)

"Double Sampling $\bar{X}$ Charts," *J. of Quality Technology*, 24, 78-87.

ABSTRACT: The purpose of this paper is to propose a new control chart, the double sampling $\bar{X}$ chart, which is the counterpart to double sampling plans. This procedure offers better statistical efficiency (in terms of the average run length) than the Shewhart $\bar{X}$ chart, without increased sampling. Alternatively, the procedure can be used to reduce the sampling without reducing the statistical efficiency. The properties (probability of a signal, average run length, average sample size, etc.) of the double sampling $\bar{X}$ chart are studied, and it is compared with variable sampling interval Shewhart charts, EWMA charts, and CUSUM charts. The double sampling chart depends on five parameters, and therefore, there is a great deal of flexibility in designing the chart. Tables are provided to aid in the choice of these parameters.

F. C. KAMINSKY, J. C. BOKAIS, R. D. DAVIS, AND R. J. BURKE (1992)

"Statistical Control Charts Based on a Geometric Distribution," *J of Quality Technology*, 24, 63-69.

ABSTRACT: In some production processes and administrative processes, the occurrence of certain events is best described by a geometric distribution. Control charts are developed for the total number of events and for the average number of events in a fixed number of units. Computer simulation is used to demonstrate the consequences of applying a standard c-chart or u-chart when the geometric model is appropriate. In a simulated example, construction of a control chart based upon a geometric distribution reduces the false alarm rate from 9.6% to 0.9%. In conclusion, two examples illustrating the applicability of these charts are presented.

Bibliography: Statistical Methods

S. EIBL, U. KESS, AND F. PUKELSHEIM (1992)

"Achieving a Target Value for a Manufacturing Process: A Case Study," *J. of Quality Technology*, 24, 22-26.

ABSTRACT: A paint coating process for which there is little information known about the relationship between the production variables and the output variables was investigated. The goal was to determine the optimum process settings to achieve the target value for the response, coating thickness. Three planned experiments of eight runs each were carried out, the first with four replicates and the other two with two replicates. The observed data were analyzed using a multiple linear regression. Four input factors appeared to be significant and were used to set the production levels in such a way that the desired coating thickness was achieved.

R. RANGANATHAN, K. K. CHOWDHURY AND A. SEKSARIA (1992)

"Design Evaluation for Reduction in Performance Variation of TV Electron Guns," *Quality Engineering*, 4, 357-370.

ABSTRACT: The cutoff voltage is a critical quality characteristic of a TV electron gun. Nonconformance means rejection of the gun costing about U.S. $3 apart from costly reclamation of the picture tube at the user TV tube plant. In order to find out the criticality of the various gun parameters with cutoff voltage, physical experimentation was infeasible. Selective assembly was not effective. Analysis of possible causes affecting cutoff voltage revealed that the effects of four gun parameters need to be evaluated as the others could be assumed to be maintained at a satisfactory level. After verification of the utility of one of several semiempirical transfer functions, this was utilized in the study using a 3^4 full factorial design. The approach was to break up the total variability of cutoff voltage into components corresponding to the four given gun parameters using Taguchi's method and the Taylor series expansion method. Both gave similar results, but the former was found to have more advantages. It was found that the most important parameter, accounted for over 80% of the total variability in the cutoff voltage. This resulted in reduction of spread about the mean by 25%, hence bringing down the nonconformance by 2%. The savings on the end product is about U.S. $25,000 per annum at 0.4 million production level.

Bibliography: Statistical Methods

M. HAMADA AND C. F. J. WU (1992)

"Analysis of Designed Experiments With Complex Aliasing," *Journal of Quality Technology*, 24, 70-77.

ABSTRACT: Traditionally, Plackett-Burman (PB) designs have been used in screening experiments for identifying important main effects. The PB designs whose run sizes are not a power of two have been criticized for their complex aliasing patterns, which according to conventional wisdom gives confusing results. This paper goes beyond the traditional approach by proposing an analysis strategy that entertains interactions in addition to main effects. Based on the precepts of effect sparsity and effect heredity, the proposed procedure exploits the designs' complex aliasing patterns, thereby turning their "liability" into an advantage. Demonstration of the procedure on three real estimates shows the potential for extracting important information available in the data that has, until now, been missed. Some limitations are discussed, and extensions to overcome them are given. The proposed procedure also applies to more general mixed level designs that have become increasingly popular.

COMMENT: Stimulated at least in part by the work and proselytizing of Taguchi there has been a heightened interest in the design of "screening experiments". This contemporary paper shows that there are still novel findings to be made in a somewhat time worn problem.

B. C. JIANG, D. W. H. CHEN, J. T. BLACK, AND J. N. HOOL

"Taguchi-based Methodology for Determining/Optimizing Robot Process Capability," *IIE Transactions*, 23, 169-184.

ABSTRACT: A Taguchi-based methodology is implemented to determine and to optimize a robot's process capability (RPC). This low-cost solution optimizes a robot's operational conditions. The experiment determines the RPC (i.e., accuracy, repeatability, reproducibility and stability) and considers seven operational factors (i.e., load, speed, distance, orientation, direction, height, and starting point) with three levels each. The results from Taguchi experimental design and data analysis show that the various factors affect each RPC characteristic differently. Therefore, an optimized combination of operational factors for each RPC characteristic is determined separately. Based on the project results, recommendations re made to use Taguchi Methods. Test results and future research needs are also discussed.

Bibliography: Statistical Methods

Miscellaneous Statistical Applications

O. CARLSSON

"Quality Selection of a Two-Dimensional Process Level under Single Acceptance Sample by Variables," *International Journal of Production Economics*, 27 (1992) 43-56.

ABSTRACT: This paper studies the quality control of hardboard a problem that includes the measurement of several quality characteristics simultaneously. Special attention was paid to the thickness and the density. Samples of sheets are taken from hardboard lots and a lot is accepted if both the mean thickness and mean density exceed given levels. If not, the lot is rejected and sold at a reduced price. The producer can reduce the risk of rejection by making a thicker and heavier board but this will increase the cost of production. The paper presents a model to determine the optimal two-dimensional process level and the optimal expected net income per lot based on assumptions of a known process variance and of a net linear income per lot. An approximate optimal two-dimensional process level is discussed and an example is given.

COMMENT: This paper is a recent example of a stream of work on setting optimal economic process targets based on costs, specifications and process variation. An interesting predecessor paper is:

W. G. HUNTER AND C. D. KARLHA (1977)

"Determining the Most Profitable Target Level for a Production Process" *J. Quality Technology*, 9, 176-180.

D. L. BANKS AND G. PARMIGIANI

"Pre-Analysis of Superlarge Industrial Data Sets," *Journal of Quality Technology*, 24, 115-129.

ABSTRACT: Successful analysis of superlarge data sets requires statistical procedures that automatically clean the data and uncover simple structure. The protocol described applies to multivariate industrial data from continuous manufacturing processes with feedback and feedforward control. Our methods form a twelve-step sequence that edits and re-logs the time series, as well as applying diagnostics to look for subtle data flaws. At different stages, the protocol will reject data, impute data, re-log the time series, flag categories of suspicious data, and divide the data set into more homogeneous subsets. The result is a clean data set ready for analysis using standard statistical packages of software tools. Although there is no

guarantee that every corruption has been caught and corrected, the output data set is more thoroughly examined than traditional human-intensive methods can achieve. To assist in this preliminary analysis, four graphical methods are described, which were developed in studies of glass manufacture from PPG Industries' production plants and sheet aluminum production by Alcoa.

COMMENT: A novel and fundamentally heuristic approach to a frequently encountered problem: industrial and commercial data bases are notoriously inaccurate and incomplete. This work is oriented toward data arising in automated manufacturing environments. Similar problems occur in other data bases including those of service enterprises.

S. R. DALAL, E. B. FOWLKES, AND B. HOADLEY, (1989)

"Risk Analysis of the Space Shuttle: Pre-Challenger Prediction of Failure," *Journal of The American Statistical Association*, 84, 945-957.

ABSTRACT: The Rogers Commission report on the space shuttle Challenger accident concluded that the accident was caused by a combustion gas leak through a joint in one of the booster rockets, which was sealed by a device called an O-ring. The commission further concluded that O-rings do not seal properly at low temperatures. In this article data from the 23 preaccident launches of the space shuttle is used to predict O-ring performance under the Challenger launch conditions and relate it to the catastrophic failure of the shuttle. Analyses via binomial and binary logistic regression show that there is strong statistical evidence of a temperature effect on incidents of O-ring thermal distress. In addition, a probabilistic risk assessment at 31°F, the temperature at which Challenger was launched, yields at least a 13% probability of catastrophic field-joint O-ring failure. Postponement to 60°F would have reduced the probability to at least 2%. To assess uncertainty in estimates and for any future prediction under the Challenger scenario, a postanalysis prior distribution of the probability of a catastrophic failure is derived.

COMMENT: This paper deals with the technical aspects of a problem with technical, social and political origins. The full story of the Challenger disaster has proven to be, as predicted by W. E. Deming on the day following the explosion, a case study of a quality hostile environment. There are many *root*

Bibliography: Statistical Methods

causes of the accident. It is worthy of study by anyone interested in TQ. For additional background see:

R. P. FEYNMAN, (1988)

"Mr. Feynman goes to Washington: Investigating the Space Shuttle Challenger Disaster," in *What Do You Care What Other People Think?*, W. W. Norton, NY, 113-238.

M. HAMADA, (1992)

"An Explanation and Criticism of Minute Accumulating Analysis," *Journal of Quality Technology*, 24, 70-77.

ABSTRACT: Minute accumulating analysis (MAA) is Taguchi's method for analyzing life test data from designed experiments. Motivated by comparing survival curves, MAA analyzes sequences of binary data generated from the life test data. This paper explains MAA and exposes numerous pitfalls caused by ignoring or misusing information provided by the data. Examples using real and synthetic data and a simulation study demonstrate that MAA can detect spurious effects, miss real effects, and reverse the order of factor importance. Consequently, MAA cannot be recommended. Standard techniques for analyzing reliability data, which correctly handle life test data, provide a valid and flexible alternative.

COMMENT: This paper is one of a series that have been published by various authors examining in detail a variety of aspects of the statistical ideas and methods o the Japanese engineer, G. Taguchi. An extensive panel discussion of many aspects of Taguchi's ideas may be found in:

V. N. NADIR (EDITOR) (1992)

"Taguchi's Parameter Design: A Panel Discussion," *Technometrics*, 34, 127-161.

An introduction to Taguchi's ideas (with some discussion) may be found in:

R. N. KACKER (1985)

"Off-Line Quality Control, Parameter Design and the Taguchi Method," *Journal of Quality Technology*, 17, 176-209.

J. INMAN, J. LEDOLTER, R. V. LENTH AND L. NIEMI

"Two Case Studies Involving an Optical Emission Spectrometer," *Journal of Quality Technology*, 24, 27-38.

ABSTRACT: This paper describes two case studies involving an optical emission spectrometer used for measuring the chemical composition of steel. The first case study describes the design and analysis of an experiment for estimating

Bibliography: Statistical Methods

some key components of variance in spectrometer measurements. The results of this experiment motivated several subsequent investigations, including the second case study: an investigation into causes of instability of the spectrometer.

A. PARASURAMAN, L. L. BERRY, AND V. A. ZEITHAML, (1991)

"Refinement and Reassessment of the SERVQUAL Scale," *Journal of Retailing*, 67, 421-450.

ABSTRACT: In a previous article we presented SERVQUAL, a multiple-item scale for measuring service quality (Parasuraman, Zeithaml, and Berry, 1988). In the present article, we discuss findings from a follow-up study in which we refined SERVQUAL and replicated it in five different customer samples. We also compare our findings with those of other researchers who have recently employed and evaluated SERVQUAL. On the basis of insights from this comparative discussion, we offer directions for future SERVQUAL research and applications.

D. LAMBERT, (1992)

"Zero-Inflated Poisson Regression, With An Application to Defects in Manufacturing," *Technometrics*, 34, 1-11.

ABSTRACT: Zero-inflated Poisson (ZIP) regression is a model for count data with excess zeros. It assumes that with probability p the only possible observation is 0, and with probability 1 — p, a Poisson (λ) random variable is observed. For example, when manufacturing equipment is properly aligned, defects my be nearly impossible. But when it is misaligned, defects may occur according to a Poisson λ distribution. Both the probability p of the perfect, zero defect state and the mean number of defects λ in the imperfect state may depend on covariates. Sometimes p and κ are unrelated; other times p is a simple function of κ such as $p = 1/(1 + \lambda^{\tau})$ for an unknown constant τ. In either case, ZIP regression models are easy to fit. The maximum likelihood estimates (MLE's) are approximately normal in large samples, and confidence intervals can e constructed by inverting likelihood ratio tests or using the approximate normality of the MLE's. Simulations suggest that the confidence intervals based on likelihood ratio tests are better, however. Finally, ZIP regression models are not only east to interpret, but they can also lead to more refined data analyses. For example, in an experiment concerning soldering defects on printed wiring boards, two sets of conditions gave about the same mean

number of defects, but the perfect state was more likely under one set of conditions and the mean number of defects in the imperfect state was smaller under the other set of conditions; that is, ZIP regression can show not only which conditions give lower mean number of defects but also why the means re lower.

F. D. KRAMER, (1990)

"Statistics and Policy in Welfare Quality Control: A Basis for Understanding and Assessing Competing Views," *Journal of The American Statistical Association*, 85, 850-855.

ABSTRACT: Designing quality control (QC) systems in public welfare programs exposes competing policy interests. Statistical design choices are not exclusively technical choices. Rather, they balance competing interests in assigning and collecting penalties and can influence how the programs themselves are run and to what ends. Thus the recent controversy round the application of financial penalties for overpayments in the nation's three family assistance programs joins statistical issues with deeper public policy concerns. This article describes the policy context in which the statistical issues are raised and the design, measurement, and estimation questions that expose competing policy interests. It descries the administration of the family assistance programs, the operation and limitations of their QC systems for addressing problems of administration, the statistical and policy issues inherent in the major QC design questions, and National Academy of Sciences and federal study findings and recent legislative reforms as they relate to the issues raised.

TQM Research Topics in Operations Management

Y. GOLHAR AND M. POLLOCK, (1992)

"Cost Savings Due to Variance Reduction in a Canning Process," *IIE Transactions*, 24, 89-92.

ABSTRACT: We investigate an extension of a canning problem of Golhar and Pollock to study the effect of a reduction in process variance on the production cost. Exact and approximate relationships are developed for cost reduction as a function of economic parameters when the fill is a normally distributed random variable and process settings are optimized.

Bibliography: Operations Management

COMMENT: This paper deals with a different formulation of optimal target setting nd offers an alternative to the views of Taguchi.

C. BURSTEIN, (1992), (1988)

"Updating the Socio-Technical Systems Approach to Organizational Change," *Manufacturing Review*, 5, 92-97.

ABSTRACT: During the 1980s, scores of manufacturers in the Americas, Europe, and the Far East attempted major technological changes only to find that their organizations were apparently incapable of accepting such changes. The unsuccessful experience of General Motors with robotics is illustrative of this. Consequently, many manufacturers turned to socio-technical design for help with the organizational aspects of technological change. However practitioners of socio-technical design have tended to cure problems in current technology rather than help avoid potential problems with vital, new technology. This article addresses the reorientation of socio-technical design to a preventive posture.

COMMENT: Managers and researchers alike see TQ implementation as a large scale multi-faceted organizational change effort. The slow pace of implementation is often frustrating, and there have been numerous requests from managers for help in managing the change process. There are a number of parallels between TQ and the Socio-Technical Systems theory that developed in England in the 1960's. A challenge is to generalize this work from "robotics" to TQ itself. For a contemporary reference on Socio-Technical Systems see:

J. C. TAYLOR, P. W. GUSTAVSON AND W. S. CARTER, (1986)

"Integrating the Social and Technical Systems of Organizations," in *Managing Technological Change*, D. D. Davis (ed), Jossey-Bass, San Francisco.

M. EBRAHIMPOUR AND B. E. WITHERS, (1992)

"Employee Involvement in Quality Improvement: A Comparison of American and Japanese Manufacturing Firms Operating in the U.S.," *IEEE Transactions On Engineering Management*, 39, 142-148.

ABSTRACT: Considerable attention has been given to identifying the elements which account for Japan's successful infiltration and dominance of the world market place, and eventually to the diagnosis that attention to quality would be critical for American firms to regain their world market position. Inherent in such a philosophical change in quality management must be a

Bibliography: Operations Management

redistribution of responsibility for quality from a single QC department to workers throughout the production operation. Coupled with this change in responsibility must also be an increased use of appropriate tools [statistical quality control (SQC) tools] to enable workers to monitor and measure quality. The above two factors will help firms to achieve atarimae hinshitsu, (given quality, i.e., producing defect-free products). This research sought to determine whether firms classified as incorporating a Japanese quality management approach had significantly higher levels of worker involvement in the quality effort as well as higher utilization of SQC tools. The three types of firms represented in this study were traditional American firms, Japanese firms operating in the U.S., and nontraditional American firms (firms emulating the Japanese approach to quality management). Results suggest that Japanese and nontraditional American firms

1. have a significantly higher level of worker involvement and
2. use simple SQC tools to a significantly higher than traditional American firms.

In addition, Japanese firms operating in the U.S. showed results comparable to these American firms practicing Japanese quality management techniques. Finally, it was concluded that many Japanese firms and nontraditional American firms are gearing up for the second phase of quality, referred to as *miryokuteki hinshitsu*, (the charm of quality, i.e., the personality of products).

COMMENT: Here is a comparative study of one of the crucial elements of TQ, namely employee involvement.

J-L. DELEERSNYDER, T. J. HODGSON, E. KING, J. O'GRADY, AND A. SAVVA, (1992)

"Integrating Kanban Type Pull Systems and MRP type Push Systems: Insights From a Markovian Model," *IIE Transactions*, 24, 43-56.

ABSTRACT: Approaches to multistate production scheduling can be conveniently classified into push type (i.e., Materials Requirements Planning (MRP) systems) or pull type (i.e., kanban systems). Each is generally thought to have both advantages and disadvantages. In this paper, a hybrid push/pull strategy is developed with the aim of gaining the advantages of both approaches. Material flow between work centers is regulated using the standard single card kanban/pull arrangement. Superimposed on this is the MRP-type information flow which feeds forward demand information

directly to one or more (but not necessarily all) work centers. A general N-stage hybrid push/pull model is developed. The results indicate that the push/pull approach has lower inventory levels and a better response to demand changes than the pure pull system. The hybrid seems to combine many of the advantages of MRP approaches while retaining much of the simplicity of kanban/pull systems.

C. McComb, J. Smith, D. McCubbrey, (1991)

"The Application Software Factory: Applying Total Quality Techniques to Systems Development," *MIS Quarterly*, 15, 567-579.

Abstract: This paper describes an approach to application software development (the Application Software Factory) that enables over 90 percent reuse of code, produces application code where quality is measured in defects per million lines of code, and generates productivity exceeding that of interpretative 4GL environments. The environment is built on top of a commercial CASE tool and does not rely on exotic technology. The delivered systems are COBOL transaction processing systems using relational database technology and are predominantly online. Two applications of approximately 200,000 lines of code have each been developed by teams at two different sites. A third application of over 2 million lines of code is nearing completion. The paper depicts the important relationships between technology, management, methods, and design approaches that comprise the Application Software Factory.

Comment: This paper deals with the application of TQ ideas normally used in manufacturing in a complex domain where professionalism, service and design issues abound. A background paper of interest is

M. A. Cusamano and C. F. Kemperer (1990)

"A Quantitative Analysis of U.S. and Japanese Practices and Performance in Software Development," *Management Science*, 36, 1384-1406.

T. Al-Dowaisan and D. Shunk, (1992)

"A Time-Based Conceptual Model of Competition in Manufacturing," *Manufacturing Review*, 5, 85-91.

Abstract: In this article, the authors examine competition in a new light — as a process that exhibits certain unique behaviors or patterns governed by a relatively stable logic that can be modified by trends or forces in the competitive environment. Unlike the traditional approach to assessing

Bibliography: Operations Management

competition, which examines competition in the context of a particular technology or manufacturing philosophy, the method described here focuses on the logical underpinnings of competitive actions, because it is essential for firms to understand current competitive logic in order to make sound business decisions. The article first identifies general behaviors exhibited by the competitive process and defines key features that describe that behavior. It then examines some current manufacturing technologies and philosophies in relationship to how they influence and are influenced by the behavior of the competitive process. The main result of this approach is the development of a time-based Conceptual Competitive Model (CC Model) that serves as a reference map for better understanding the nature of competition and the possible outcomes of various competitive moves. The model may be used by manufacturing decision makers to judge the time feasibility of these competitive moves and resulting countermoves.

G. BRUNELLO, (1992), (1988)

"The Effect of Unions on Firm Performance in Japanese Manufacturing," *Industrial and Labor Relations Review*, 45, 471-487.

ABSTRACT: Using data on a sample of 979 union and nonunion Japanese manufacturing firms selected from the 1987 issue of the Yearbook of Japanese Unlisted Companies, the author examines the relationship between union status and firm performance in Japan. The findings suggest that Japanese unions in the sample substantially reduced both productivity and profitability, as well s regular wages net of bonuses and fringes. These three union effects were considerably smaller in small and medium-size firms than in large firms, perhaps because many of the small and medium-size firms were subcontractors that were pressed by the firms contracting them to cut costs and increase productivity.

COMMENT: As Japanese manufacturing and TQ methods are exported, observers are very interested in their adaptability to other cultures and political systems. The issue of unions is often central.

A. E. EATON, M. E. GORDON AND J. H. KEEFE, (1992)

"The Impact of Quality of Work Life Programs and Grievance System Effectiveness on Union Commitment," *Industrial and Labor Relations Review*, 45, 591-604.

Bibliography: Operations Management

ABSTRACT: Based on an analysis of data from a 1987 survey of four different bargaining units within the same local union, the authors conclude that union members who participated in Quality of Work Life (QWL) programs were less likely than nonparticipants to view QWL as a threat to the union, and also more loyal to the union. Another finding, however, is that the perceived effectiveness of the grievance procedure was a much stronger determinant of attitudes toward the union than was participation in QWL programs — leading the authors to speculate that one way for unions to strengthen their ties with their members might be to improve the effectiveness of the grievance procedure.

L. J. PORTER AND P. RAYNER

"Quality Costing for Total Quality Management," *International Journal of Production Economics*, 27 (1992) 69-81.

ABSTRACT: Many organizations competitiveness is seriously damaged by the quality related costs of correcting errors, redoing things, apologizing to customers, etc. An extensive survey of the published literature in this field shows that the median quality cost expressed as a percentage of sales turnover is 18%. A survey of small firms in the North of England showed that only a minority of firms systemically monitor quality costs and that quality costs are frequently underestimated. Total Quality Management (TQM) focuses on processes and process improvement. The widely recognized P-A-F Quality Cost Model does not address processes and is of limited use in a TQM program. Newer techniques such as Process Cost Modelling use a process approach and integrate quality costs and benefits contribute to quality improvement itself. A simple Cost-Benefit Model is developed to illustrate this aspect.

COMMENT: This paper takes a serious look at one of the basic assertives of TQM ideology: that quality related costs are very significant. The survey done here is an important first step in providing empirical data relevant to this issue. Background on the concepts of quality related costs may be found in:

J. M. JURAN AND F. M. GRYNA (1986)

The Quality Control Handbook 4th Edition, McGraw-Hill, N.Y.

A literature review is given by

Bibliography: Operations Management

J. J. PLUNKETT AND B. G. DALE, (1987)

"A review of the Literature on Quality Related Costs," *International J. of Quality and Related Management* 4(11), 40-52.

Y. S. CHEN AND K. TANG

"A Pictorial Approach to Poor-Quality Cost Management," *IEEE Transactions on Engineering Management*. 39, 149-157.

ABSTRACT: Controlling the cost of poor quality is an important issue in today's competitive business environment. In this paper, a pictorial approach to modeling poor-quality cost (PQC) is proposed. The approach is patterned after that used in a computer-based information system design. It includes two major steps:

1. specifying the PQC variables as well as the significant relationship among the variables, and mapping the variables and relationships into an influence diagram showing the structure of a PQC system; and
2. converting the structure into a well-defined entity-relationship diagram showing the input-output functions and their associated properties.

Two major benefits of using the pictorial approach are:

1. the influence diagram can provide an easy-to-understand PQC system for quality management practitioners; and
2. the entity-relationship diagram can provide an effective framework for maintaining and revising the PQC system.

B. G. DALE AND K. LIGHTBURN

"Continuous Quality Improvement: Why Some Organizations Lack Commitment," *International Journal of Production Economics*, 27 (1992) 57-67.

ABSTRACT: This paper makes the claim that not all companies are willing to embrace the fundamentals of Total Quality Management (TQM) and goes on to outline six levels of adoption. It is argued that there are a considerable number of companies who are using all the popular quality management tools and techniques and have met second and third party assessments of their quality system, yet are using TQM techniques, procedures and systems in a superficial manner. The main cause is a lack of management commitment to the principles of TQM and quality improvement and ineffective leadership of the improvement process. Drawing on research in the areas of initial sample inspection reporting, statistical process control and mistake proofing in an automotive component supplier operating at this level of TQM adoption,

evidence is provided on the problems caused by a lack of dedication to continuous company-wide quality improvement.

COMMENT: This paper examines what may be the number one issue of total quality management: Why is implementation no difficult and so in consistent? The issues get the strategic and leadership aspects of TQ as well as to operational issues. Concerns about management of organizational change and innovation are dominant. There are parallels with difficulty in implementing other technological or social changes to the enterprise and researchers skilled at such examination should be encouraged to take TQ as a subject. An example of such a study that builds on theories of organizational change is:

P. DUCHESSI, C. M. SCHANGINGER, D. R. HOBBS AND L. P. PENTAK," (1988)

"Determinants of Success in Implementing Material Requirements Planning," *Manufacturing and operations Management* 1, 263-304.

R. W. SCHMENNER (1988)

"Behind Labor Productivity Gains in the Factory," *Journal of Manufacturing and Operations Management*, 1, 323-338.

ABSTRACT: This paper uses three distinct factory-specific data sets — an American mail survey, an international mail survey, and data-gathering from a series of American plant visits — to identify statistically which of many factory policies and characteristics differentiate the top performers from others. The results are hearteningly consistent across data sets and strongly support the elements of just-in-time manufacturing s labor productivity-enhancing.

COMMENT: This paper examines what may be the number one issue of total quality management: Why is implementation no difficult and so inconsistent? The issues get to the strategic and leadership aspects of TQ as well as to operational issues. Concerns about management of organizational change and innovation are dominant. The paper uses a regression analysis of survey data to identify factors which contribute to productivity. Among those studied are MRP and SQC. Serious and careful work on the components of TQ itself might help to identify which of its components are most effective. Work in a similar spirit is reported in:

Bibliography: Operations Management

R. H. HAYES AND K. B. CLARK (1985)

"Exploring the Services of Productivity Differences at the Factory Level," in The Uneasy Audience: Managing the Productivity-Technology Dilemma, K. B. Clark, R. H. Hayes and C. Lorentz (editors), Boston, HBS Press, 151-194.

A. H. AMSDEN (1989)

"Learners as Producers: Hyundai Heavy Industries, the World's Largest Shipbuilder," *J of Manufacturing and Operations Management*, 2, 124-144.

ABSTRACT: The production practices of leading companies in late-industrializing companies such as Japan and Korea are not culturally determined, rather, they appear to be related systematically to a central fact of "late industrialization" — they have grown by borrowing foreign technology, or what I call "learning." This is sharp contrast to the growth of leading firms in earlier industrial revolutions, which are characterized by either "invention" or "innovation." The behavior of learners and innovators is categorically distinct; and this distinction is evident today in mature industries where competition occurs between (and among) leading firms from late-industrializing countries and long-established innovators from earlier industrial revolutions. Borrowing rather than generating new technology implies that firms compete without novel product or process. The necessity to create alternative sources of competitive advantage has given rise to distinct behavioral patterns. The most important tendencies are:

1. Government intervention in the economies to be greater;
2. There is greater emphasis on education — formal and foreign technical assistance, which makes low wage labor — more effective;
3. Industry is dominated by big business groups that diversify into unrelated industries more widely than previously; and
4. The strategic focus of the firm is the shop floor, not the design office or R & D lab.

These hypotheses are supported with a case study of a Korean firm, Hyundai Heavy Industries (HHI), and the learning process behind its emergence as the world's largest shipbuilder. Then, I extrapolate from the case study to suggest some contrasts in the production systems of learners, inventors, and innovators in the general case.

Bibliography: Operations Management

COMMENT: This paper deals with an emerging them of TQ, learning organization. While not dealing with TQ per se the issues of quality, quality improvement and the relationship of quality and productivity are crucial.

P. ADLER, A. MANDELBAUM, V. NGUYEN, AND E. SHWERER, (1992) "From Project to Process Management in Engineering: An Empirical Study of Product Development," *Working Paper, Stanford University*.

ABSTRACT: Product development work has often been studied as though it consisted of isolated unique projects. With this approach, organizations' activities can be described in terms of PERT models which either do not acknowledge resource limitations at all or assume that resources are dedicated to specific projects. However, many product development organizations do not rely on fully-dedicated teams, so their projects suffer delays when resources have to support more than one project concurrently. This study develops an empirically-based framework for analyzing development time in such contexts. We model the product development organization as a stochastic processing network in which engineering resources are "workstations" and projects are "jobs" that flow among the workstations. At any given time, a job is either receiving service or queuing for access to a resource, and our model's spreadsheets and simulations quantify the amount of time it spends in each.

This class of models provides a framework for studying product development because it enables formal performance analysis, and it points to data that should be collected by organizations seeking to improve development cycle times. These models can serve as management tools, for example, to support decisions regarding resource allocation and to help in predicting project completion time. They also provide a valuable conceptual framework for exploring the commonalities and differences between engineering and manufacturing operations.

COMMENT: This paper presents a link between concerns of TQ oriented firms to improve the product development process reduce cycle times and the like with tools created by industrial engineers and management scientists to model and improve processes namely PERTI cpm models, queuing analysis and system simulation. an interesting reference to the problem context is

Bibliography: Operations Management

K. B. CLARK AND T. FUJIMOTO (1991)

Product Development Performance: Strategy, Organization and Management in the World Auto Industry, HBS Press, Boston.

N. CAPON, J. U. FARLEY, D. R. LEHMANN AND J. M. HULBERT (1992)

"Profiles of Product Innovators Among Large U.S. Manufacturers*," *Management Science* 38, 157-169.

ABSTRACT: This paper identifies four groups among 113 *Fortune 500* manufacturers that approach innovation quite differently. The groups are based on 27 measured elements of corporate environment, corporate strategy, and formal and informal organization. Both product innovation and financial performance differ significantly over the groups, and a group of 42 firms that invest heavily in innovation perform best financially. A smaller group of firms that are not innovative but which follow a strategy of acquisition perform nearly as well financially. Firms focusing research resources on process innovation perform poorly, although process research complements product research among the effective innovators. Particularly important for explaining both product innovation and financial performance of these firms are salient combinations of classic elements of good environment, good strategy and good organization-strong positions in growing markets, investment in research and development, open and creative organizational structures and supportive organizational climates.

COMMENT: A major theme of TQ is the need to innovate more effectively. This paper makes an attempt to distinguish characteristics that predict successful innovation. Could parallel methodology be applied to TQ itself?

A. GRIFFIN AND J. R. HAUSER (1992)

"Patterns of Communication Among Marketing Engineering and Manufacturing — A Comparison Between Two New Product Teams," *Management Science*, 38, 360-373.

ABSTRACT: Models and scientific evidence suggest that firms are more successful at new-product development if there is greater communication among marketing, engineering, and manufacturing. This paper examines communication patterns for two matched product-development teams where the key difference between the groups is that one used a phase-review development process and the other used Quality Function Deployment (QFD), a product-development process adopted recently at over 100 United

States and Japanese firms. To our knowledge, this is the first head-to-head comparison of traditional U.S. product development processes with QFD. Our data suggest that QFD enhances communication levels within the core team (marketing, engineering, manufacturing). QFD changes communication patterns from "up-over-down" flows through management to more horizontal routes where core team members communicate directly with one another. On the other hand, the QFD team communicates less on planning information and less with members of the firm external to the team. If this paucity of external communication means that he team has the information it needs for product development, and the QFD process has provided an effective means for moving the information through the team, it is a positive impact of QFD. If the result means that QFD induces team insularity, even when the team needs to reach out to external information sources, it is a cause of concern.

COMMENT: Quality Function Deployment is one of the very highly touted quality management tools to merge from Japan. This is the first study of effectiveness. There is a great need for more comprehensive study of this technique.

J. C. HENDERSON AND S. LEE (1992)

"Managing I/S Design Teams: A Control Theories Perspective," *Management Science*, 38, 757-177.

ABSTRACT: The control relationship between project managers and team members is a central aspect of the working of any Information System (I/S) design team. This paper combines research on managerial control and team-member control in order to explore a range of control behaviors that can affect the performance of an I/S design team. Measures are developed and validated for managerial control and team-member control from both an outcome and a process perspective. Results from a study of 41 actual I/S design teams indicate that high-performing teams exhibit high process control by managers and high outcome control by team members. The results also support the proposition that both managerial and team-member control coexists and that increases in the total level of control behavior is positively correlated with performance.

COMMENT: The preceding paper on Quality Function Deployment and the paper by Clark and Fujimato (1991) cited earlier look at different aspects of

the design process. This paper takes still another view of the vital issue of effective and efficient design process management.

P. LEFRANCOIS, M. C. ROY AND G. GAMACHE (1990)

"Estimation of the Mean Flow Time in a Rolling-Mill Facility," *J of Manufacturing and Operations Management*, 3, 134-152.

ABSTRACT: This paper presents results from the application of a queuing network model developed to estimate the mean flow time in a rolling-mill facility. The queuing model accounts for random-batch size jobs that arrive intermittently over time and belong to given priority classes. Insights on a spreadsheet implementation of the model are also presented.

COMMENT: As the total quality movement rediscovers basic industrial engineering concepts and revitalizes and broadens them, we can also expect that it will rediscover basic operations research and management service techniques. This paper uses such basic tools on one of TQ's central concerns: management of flow times.

R. A. DUDEK, S. S. PANWALKAR AND M. L. SMITH (1992)

"The Lessons of Flowshop Scheduling Research," *Operations Research*, 40, 7-16.

COMMENT: This paper can be read as a model for how not to conduct a research agenda. Building on an elegant but unrealistic 1954 paper, researchers generated 38 years with of other elegant but unrealistic papers. Thus their work is almost completely out of touch with reality. The authors make some observations on why this happened and what must be done to avoid this disconnection in the future. It is advice that TQ oriental researchers should be aware of. The suggested sources of the dilemma include:

1. The problem as described by the researchers seldom or never exists.
2. The problem may exist but with multiple and complex criteria or goals.
3. The assumptions required for the algorithm to work are overly restrictive and actual problems don't obey them.
4. The algorithms are inflexible and not robust. They can't be adapted to handle reality.
5. The real problems have characteristics that are quite different from those assumed by the researchers.

Bibliography: Operations Management

The Just-in-Time Theme

An important theme of The TQ movement is "just-in-time" manufacturing or more broadly just-in-time management. Though it is now seen in the U.S. as being intimately linked to TQ, that linkage is emphasized for less in Japan. Indeed, at Toyota Motor Corporation where JIT and the Kan-ban system for implementing it were born its development was completely distinct from TQ. A basic descriptions of TQ from the Japanese viewpoints may be found in

Y. MONDEN (1983)

Toyota Production System: Practical Approach to Production Management, Norcross, GA, Management Press, Institute of Industrial Engineers.

S. SHINGO, (1989)

A Study of the Toyota Production System form an Industrial Engineering Viewpoint, Cambridge, The Productivity Press.

An American analysis and perspective is given in

P. ZIPKIN, (1991)

"Does Manufacturing Need a JIT Revolution?," *Harvard Business Review* Jan-Feb 4-10.

The following two papers are recent attempts by researchers to establish theoretical bases for understanding the JIT phenomena:

M. L. SPEARMAN AND M. A. ZAZANIS, (1992)

"Push and Pull Production Systems: Issues and Comparisons," *Operations Research* 40, 521.

ABSTRACT: Concerns about American manufacturing competitiveness compel new interest in alternative production control strategies. In this paper, we examine the behavior of push and pull production systems in an attempt to explain the apparent superior performance of pull systems. We consider three conjectures: that pull systems have less congestion; that pull systems are inherently easier to control; and that the benefits of a pull environment owe more to the fact that WIP is bounded than to the practice of "pulling" everywhere. We examine these conjectures for analytically tractable models. In doing so, we not only find supporting evidence for our surmises but also identify a control strategy that has push and pull characteristics and appears to outperform both pure push and pure pull systems. This hybrid system also appears to be more general in its applicability than traditional pull systems such as Kanban.

Bibliography: Operations Management

R. D. BADINELLI (1992)

"A Model for Continuous-Review Pull Policies in Serial Inventory Systems," *Operations Research* 40, 142-150.

ABSTRACT: In this paper, we construct a model of the steady-state values of on-hand inventory and backorders for each facility of a serial inventory system in which each facility follows a (Q, R) policy based on installation stock. Such policies are represented by the popular kanban systems as well as more conventional applications of (Q, R) policies. The descriptive model presented here is intended for optimizing the parameters of such a policy and for obtaining theoretical result about the behavior of the system. We also illustrate the potential of the model for providing insights into system performance.

A. S. WEIN, "RANDOM YIELD

Rework and Scrap in a Multistage Batch Manufacturing Environment," *Operations Research*, 40, 551-560.

ABSTRACT: This study is motivated by a make-to-order marketing environment where an order is met from a single production lot size. The objective of the study is to endogenize rework and scrap decisions in a multistage production process. A Markov decision process model is developed and solved using dynamic programming techniques. The model assumes that demand is given, and material, processing and rework costs are linear in the production lot size. Modeling random yield at each stage of the production process is of key interest. The solution to the problem is characterized and the sensitivity of the solution to the parameters of the model is examined.

COMMENT: This paper employs operations research methods to analyze what is essentially a quality problem in the production of computer chips. It does not take a TQ approach of attacking the root causes of the defects but rather finds an optimal plan to work around them. This is part of an emerging stream of OR based research on such problems, and we can expect more integration of TQ and OR ideas in the future.

L. A. MARTIN-VEGA (1992)

"Design and Manufacturing: An NSF Perspective," *IIE Transactions*, 24, 98-103.

ABSTRACT: The Division of Design and Manufacturing Systems (DDM) was created at the National Science Foundation in 1984 to support research that seeks to serve a broad spectrum of U.S. industry by developing and

expanding the scientific and engineering foundations of design, manufacturing and production. This objective is accomplished through support of individual investigators and the implementation of special initiatives that encourage academic teaming as well as interaction between academia and industry. This paper presents an overview of these initiatives along with a summary of current activities and research trends.

References in Accounting and Finance:

As primary sources of research opportunities we reference the following works. The first should be read before consulting the others.

Relevance Regained: From Top-Down Control to Bottom-Up Empowerment by H. Thomas Johnson. Free Press: New York, NY, 1992.

The Design of Cost Management Systems: Text, Cases, and Readings by Robin Cooper and Robert S. Kaplan. Prentice Hall: Englewood Cliffs, NJ, 1991.

Cost Management in the New Manufacturing Age: Innovations in the Japanese Automotive Industry by Yasuhiro Monden. Productivity Press: Cambridge, 1992.

TQC for Accounting: A New Role in Companywide Improvement by Takashi Kanatsu. Productivity Press: Cambridge, 1990.

Japanese Management Accounting: A World Class Approach to Profit Management edited by Yasuhiro Monden and Micihiharu Sakurai. Productivity Press: Cambridge, MA, 1990.

Emerging Practices in Cost Management edited by Barry J. Brinker. Warren, Gorhan and Lamont: New York, 1990.

Cost Management Systems: A Digest of the Relevant Literature (Volume II) edited by William G. Sullivan and Charles D. Mecimore. Institute of Management Accountants: Englewood Cliffs, NJ, 1991.

Articles that Suggest Key Research Questions in Finance and Accounting

The annotated articles listed in the pages that follow were selected primarily because they suggest research topics appropriate for TQ. It was not our intention to evaluate these articles and these articles were not selected because of the quality of their research content. The list simply provides examples relating to important research questions and is not comprehensive.

TITLE: Pitfalls in Using ABC Cost-Driver Information to Manage Operating Costs

Bibliography: Accounting and Finance

AUTHORS: Johnson, H. Thomas; Vance, Thomas P.; Player, R. Steven

JOURNAL: Corporate Controller Vol: 3 No: 3 Date: January-February 1991 pp.: 26-32 ISSN: 0899-0174

ABSTRACT: The authors caution executives not to be misled by exaggerated claims being made on behalf of new activity-based costing techniques. Such techniques do reduce egregious distortions in product cost information caused by allocating indirect costs strictly according to volume (as in traditional systems that allocate all indirect costs over direct-labor hours). But product cost accounting information is not necessarily useful for choosing the right products and processes, no matter what care is taken to allocate indirect costs. The right products are the ones customers want, delivered the way customers want them. Those products are not necessarily the ones your accounting system — even an activity-based system — says are the most profitable. In the global era of Total Quality, management's job is to design processes and systems that profitable produce what customers want — not push down customers' throats what the accounting system says is most profitable.

TITLE: It's Time to Stop Overselling Activity-Based Concepts

AUTHORS: Johnson, H. Thomas

JOURNAL: Management Accounting Vol: LXXIV No: 3 pp.: 26-35 ISSN: 0025-1690

ABSTRACT: The article advances the author's thesis, elaborated in his book *Relevance Regained: From Top-Down Control to Bottom-Up Empowerment* (The Free Press, 1992), that activity-based cost management erroneously presumes that improvements to accounting information can make management accounting a useful tool for controlling business operations in the era of Total Quality. The author argues that all accounting information, including activity-based varieties, is deaf to the voice of the customer and the voice of the process — the only information that is relevant to controlling operations in a flexible, customer-focused learning organization.

A new academic journal to mention: *Production and Operations Management: An International Journal for the Production and Operations Management Society.* Published at the University of Baltimore in Baltimore, MD. For information, call the Editor, Kalyan Singhal, Professor of Management at University of Baltimore, (301) 625-3261.

Bibliography: Accounting and Finance

TITLE: Capital Resource Allocation for Strategic Quality Management

AUTHORS: Andreou, Stefanos A.

JOURNAL: International Journal of Technology Management Vol: 6 Iss: 3,4 Date: 1991 pp: 415-426 Jrnl Code: ITN ISSN: 0267-5730

TERMS: Quality control; Resource allocation; Market shares; Profitability; Strategic planning; Capital budgeting

CODES: 5320 (Quality control); 2310 (Planning); 3100 (Capital & debt management)

ABSTRACT: Product and process quality is of critical importance in today's manufacturing environment. New technologies can create significant opportunities for quality improvements, which in turn could result in increases of future profitability. Thus, there is a need for systematic evaluation of investment alternatives and trade-offs. Traditional capital budgeting methods should be augmented to establish better quantitative approximations of the benefits and costs of quality, which are often treated as intangible in today's capital appropriation proposals. A financial evaluation framework is proposed that integrates recently developed techniques for quantifying the impact of quality improvements. These techniques include:

1. a new overhead allocation method that uses quality cost drivers,
2. modern finance principles that help quantify growth opportunities created by quality differentiation, and
3. empirical studies that link quality with market share and profitability.

Charts. Graphs. Equations. References.

TITLE: Linking the Shop Floor to the Top Floor

AUTHORS: Beischel, Mark E.; Smith, K. Richard

JOURNAL: Management Accounting Vol: 73 Iss: 4 Date: Oct 1991 pp: 25-29 Jrnl Code: NAA ISSN: 0025-1690

TERMS: Manufacturing; Performance evaluation; Quality control; Customer services; Performance standards; U.S.

CODES: 8600 (Manufacturing industries); 5320 (Quality control); 2400 (Public relations); 9190 (United States)

ABSTRACT: The first step in establishing a manufacturing performance measurement framework is to establish manufacturing's "Critical Success Factors," items so important that, without any one of them, a company would fail. These factors include:

Bibliography: Accounting and Finance

1. quality,
2. customer service, and
3. cost.

The only effective way to measure results at the shop floor and concurrently measure overall manufacturing performance through critical success factors is to link the measures at each management level. All actions taken in any for-profit enterprise ultimately affect the financial health of that company. Once the manufacturing measures have been linked throughout the organization, a measurement system or series of scorecards can be designed. Scorecards and measures differ at each management level in the frequency of measures and the span of control. Charts.

TITLE: Improving White Collar Productivity Can Enhance Profitability

AUTHORS: Bhote, Keki R.

JOURNAL: Corporate Controller Vol: 3 Iss: 5 Date: May/Jun 1991 pp: 39-46 Jrnl Code: COP ISSN: 0899-0174

Company: Motorola Inc (DUNS: 00-132-5463)

TERMS: White collar workers; Productivity; Total quality; Organizational change; Techniques; Implementations; Accounting policies; Case studies; U.S.

CODES: 2500 (Organizational behavior); 9190 (United States); 4120 (Accounting policies & procedures); 9110 (Company specific)

ABSTRACT: While U.S. manufacturing is finally making progress in the quality arena, quality is virtually ignored among the services that support manufacturing, such as marketing and personnel. An Illinois Institute of Technology study found that blue-collar productivity has been consistently above 80% and rising, but white-collar productivity has been below 40% and falling. White-collar productivity is important because, through greater customer and employee satisfaction, companies can improve their profits, return on investment, and market share. The Next Operation As Customer (NOAC) technique can improve quality, cost, and cycle time in any white-collar operation. NOAC's basic principles are:

1. The internal customer is a prince.
2. All work can be considered a process.
3. Effectiveness is measured through the internal customer's evaluation.
4. The consequences of meeting or not meeting the internal customer's requirements include commensurate rewards or penalties. Charts.

Bibliography: Accounting and Finance

TITLE: Measuring Project Success

AUTHORS: Freeman, Mark; Beale, Peter

JOURNAL: Project Management Journal Vol: 23 Iss: 1 Date: Mar 1992 pp: 8-17 Jrnl Code: PMJ ISSN: 8756-078X

TERMS: Measurement; Net present value; Criteria; Project evaluation; Project management; Mathematical analysis

CODES: 3100 (Capital & debt management); 2310 (Planning)

ABSTRACT: The success or failure of a business venture can be objectively measured in terms of marketing achievement, technical achievement, or financial achievement. A discounted cash flow (DCF) approach is superior to other popular financial measures, partly because of its objectivity. The main criteria for measuring the success of projects are:

1. technical performance,
2. efficiency of project execution,
3. managerial and organizational implications,
4. personal growth,
5. project termination,
6. technical innovativeness, and
7. manufacturability and business performance.

Given that achieving targets of time, cost, scope, and quality are most highly rated as measures of success, sponsors and project managers must have an objective measuring system to show how successfully they have achieved these targets. The success or failure of a project can be measured at any point during its progress. Project success can be measured from the viewpoints of a sponsor, an external project manager, and a sponsor managing an internal project. Graphs. Equations. Charts. References.

TITLE: Let There Be Light!

AUTHORS: Gray, William S.

JOURNAL: Financial Analysts Jrnl Vol: 46 Iss: 5 Date: Sep/Oct 1990 pp: 4-5 Jrnl Code: FIA ISSN: 0015-198X

TERMS: Consumer Price Index-U.S.; Price increases; Inflation; Product design; Improvements

CODES: 9190 (United States); 1110 (Economic conditions & forecasts); 7500 (Product planning & development)

Bibliography: Accounting and Finance

ABSTRACT: The Consumer Price Index (CPI) is the most widely used measure of the weighted price increase of goods and services in the U.S. However, it is not known how much of these measured price changes have been, are, or will be real inflation. Observers have noted that price changes and inflation are not identical. At least one study in the mid-1960s concluded that most, if not all, CPI increases prior to that time reflected product quality improvements — not inflation. Product price increases also have occurred as business has been required to provide a portion of many public services. These increases represent a "pass through" of such costs. These constitute a 2nd category of price increases that are not real inflation. The 1989 CPI increase of 4.6% could be seen as made up of 1.5% product quality improvements, 1.0% public services, and 2.1% real inflation. This altered perception of the makeup of price increases might affect the decisions of investors who focus on required real returns. The Association for Investment Management and Research could attempt to identify people or sources that could shed light on this matter.

TITLE: Do Financial and Nonfinancial Performance Measures Have to Agree?

AUTHORS: McNair, Carol J.; Lynch, Richard L.; Cross, Kelvin F.

JOURNAL: Management Accounting Vol: 72 Iss: 5 Date: Nov 1990 pp: 28-36 Jrnl Code: NAA ISSN: 0025-1690

TERMS: Cost accounting; Just-in-Time; Management accounting; Information management; Cost control; Accounting policies

CODES: 4120 (Accounting policies & procedures)

ABSTRACT: The conflict between financial and nonfinancial performance measures causes tension, clouds action, and often polarizes factions within companies. Symptoms of tension are common, and the underlying issue is that everyone involved is trying to do what is best for the company but are coming at it in different ways. To replace the traditional focus, a new strategic measurement system has been developed. It is based on concepts of total quality management, industrial engineering, and activity accounting. A 2-way communications system is required to institute the strategic vision in the organization. Management accountants should be participating in the information revolution and suggestions on how to do this include:

1. providing the right information at the right time,
2. switching from scorekeeper to coach, and
3. focusing on what counts the most.

Bibliography: Accounting and Finance

Interpreting the financial and nonfinancial signals of the business and responding to them even when they do not agree is a management issue, not an accounting issue. Tables. Charts. References.

TITLE: How to Develop Measures for Financial Work

AUTHORS: Minnis, Perry A.

JOURNAL: National Productivity Review Vol: 11 Iss: 2 Date: Spring 1992 pp: 159-167 Jrnl Code: NLP ISSN: 0277-8556

TERMS: Guidelines; Performance evaluation; Financial management; Total quality; Customer satisfaction; Improvements

CODES: 5320 (Quality control); 3100 (Capital & debt management); 4120 (Accounting policies & procedures); 9150 (Guidelines)

ABSTRACT: The quality of a product or service is the result of the interaction among the individual performer, the process, and management. An organization must examine how its product or service ultimately will be used and identify, as well as measure, the attributes that will provide the greatest overall level of customer satisfaction. A 4-step process of developing appropriate measures involves:

1. identifying the most significant outputs being produced,
2. identifying the critical characteristics of performance for each of these outputs,
3. developing the measures that best indicate customer satisfaction, and
4. deciding on performance goals for each measure.

The collection of data and the comparison of actual performance to the standards are necessary to identify gaps or opportunities for improvement. Charts.

TITLE: J. I. Case Company: Performance Measurement

AUTHORS: Sellenheim, Michael R.

JOURNAL: Management Accounting Vol: 73 Iss: 3 Date: Sep 1991 pp: 50-53 Jrnl Code: NAA ISSN: 0025-1690

Company: J I Case Co (DUNS: 00-131-5019)

TERMS: Case studies; Machinery industry; Farm machinery; Quality control; Just-in-Time; Cost control; Efficiency

CODES: 9110 (Company specific); 8670 (Machinery industry); 5320 (Quality control); 9190 (United States)

Bibliography: Accounting and Finance

ABSTRACT: The J. I. Case Agricultural Equipment Group, a division of Tenneco Inc., incorporated the following general categories of performance measurements to achieve world-class manufacturing (WCM) status:

1. quality,
2. delivery,
3. production process time,
4. flexibility, and
5. finance costs.

A good performance measurement system must be designed to support the WCM objective of Kaizen, a Japanese term that means continual improvement. It should focus on how the company is performing today and indicate where the organization needs to improve. Charts.

TITLE: Towards Decision-Useful Management Accounting

AUTHORS: Smith, Malcolm

JOURNAL: Management Accounting (UK) Vol: 67 Iss: 8 Date: Sep 1989 pp: 70-71,73 Jrnl Code: MAC ISSN: 0025-1682

TERMS: Management accounting; Just-in-time; Manufacturing; Quality control; Employee involvement; Accountants; Cost reduction

CODES: 8600 (Manufacturing industries); 4120 (Accounting policies & procedures)

ABSTRACT: Just-in-time (JIT) manufacturing systems have created a perception among many management accountants that places undue emphasis on stock control methods. JIT can be more appropriately considered a part of a wider process in which attitudinal changes are central to the development of more efficient management processes and generate the adoption of more decision-useful management accounting measures. This wider process, known as value added management (VAM), is concerned with the identification and elimination of all nonvalue-adding waste in the manufacturing process. The application of VAM principles aims at reducing costs in certain areas and at increasing quality in others. For the VAM system to operate effectively, management accountants must be able to provide decision-useful information. Since much of this information is nonfinancial and some is qualitative, creative management accounting is needed to quantify and integrate the potential benefits of VAM. References.

TITLE: Quality Management Beyond Manufacturing

Bibliography: Accounting and Finance

AUTHORS: Tenner, Arthur R.

JOURNAL: Research-Technology Management Vol: 34 Iss: 5 Date: Sep/Oct 1991 pp: 27-32 Jrnl Code: RMG ISSN: 0895-6308

TERMS: Total quality; Competitive advantage; Applications; Implementations; Improvements; Strategic planning

CODES: 5320 (Quality control); 2310 (Planning)

ABSTRACT: Capturing the competitive advantage offered by total quality management is possible in all types of businesses, from manufacturing through service. Furthermore, the techniques can be applied to all functions within an organization, including information systems, marketing finance, and research and development. However, adaptation becomes necessary as the characteristics of the work process under investigation diverge from those of classical, repetitive manufacturing for which the methods were originally designed. A model has been developed to extend process improvement beyond manufacturing. Applications most likely to benefit from this model include those in which:

1. the presence of an underlying business system is not clear,
2. customers requirements are difficult to define, and
3. the work process is not documented, or
4. its performance is hard to measure. Charts. References.

TITLE: How We Changed Our Accounting

AUTHORS: Woods, Michael D.

JOURNAL: Management Accounting Vol: 70 Iss: 8 Date: Feb 1989 pp: 42-45 Jrnl Code: NAA ISSN: 0025-1690

TERMS: Case studies; Navy-U.S.; Quality control; Cost accounting; Accounting procedures; Cost allocation; Product costing; Production costs; Cost allocation methods; Improvements

CODES: 9110 (Company specific); 9550 (Public sector); 5320 (Quality control); 4120 (Accounting policies & procedures)

ABSTRACT: In 1985, when Rear Admiral John H. Kirkpatrick assumed command of the 6 U.S. Naval Aviation Depots, he inaugurated the use of total quality management as a means of improving service to the fleet and the country.

Bibliography: Accounting and Finance

The goal of any total quality system is to improve the usefulness of the final product and to reduce product costs. The Navy depots attempt to do 4 things to improve the quality (usefulness) of the cost accounting products:

1. Collect costs by process.
2. Assign costs to production and service processes according to the degree to which those processes incur costs.
3. Whenever possible, allow the internal customer to demand only those internal products or services desired.
4. Assign process costs to products according to the degree to which the products "use" the processes.

There have been no failures by any of the accounting total quality teams. The primary improvements at one depot have been lower labor rates, improved business systems, technology advancements, and timely service to the fleet. Diagrams.

TITLE: New Roles for Communications Managers and Departments

AUTHORS: Anonymous

JOURNAL: Jrnl for Quality & Participation Date: Jan/Feb 1990 pp: 40-42 Jrnl Code: QCJ ISSN: 1040-9602

TERMS: Telecommunications; Departments; Changes; Roles; Quality; Customer services

CODES: 5250 (Telecommunications systems); 5320 (Quality control)

ABSTRACT: In an interview, David Rubin, a senior consultant with Arthur D. Little Inc., discussed how the telecommunications department in organizations fits into the total quality process. Historically, the telecommunications department was considered part of finance or administration. Telecommunications services were regarded by the user departments as commodities, and purchase decisions were largely cost driven. The recent ascendancy of telecommunications departments in many companies is occurring because of its increasing business significance. Telecommunications is playing key consulting and planning roles in the development of corporate infrastructures necessary for low costs, competitive edge products, and responsive services, as well as fast, efficient electronic

Bibliography: Accounting and Finance

linkages to external business partners. The delivery of good quality and customer service demands sophisticated systems and networks. The telecommunications department and manager are critical players of the team that must plan, implement, operate, and maintain the systems needed for quality and customer service. Charts.

Reference: Cross-Functional Management

"Development of cross-functional management in Japan," by Yoshio Kondo, *Total Quality Management*, Vol. 2, No. 1, 1991, pp. 17-28.

The Center for Quality and Productivity Improvement
University of Wisconsin
Report List

610 Walnut Street
Madison, Wisconsin 53705
Phone: 608/263-2520
September 23, 1992

Letter codes indicate report type:

T = Technical, M = Management, G = General, S = Case Study

No.	Title/Description
1. T	**Studies in Quality Improvement: Dispersion Effects from Fractional Designs** by George Box and R. Daniel Meyer, (February 1986). The expense of repeating measurements can sometimes be avoided by using unreplicated fractional factorials to identify factors that affect dispersion. Publication(s): *Technometrics*, Vol. 28, No.1, (1986) pp. 19-27.
2. T	**An Analysis for Unreplicated Fractional Factorials** by George Box and R. Daniel Meyer, (February 1986). New procedures for analyzing unreplicated fractional factorial designs make them easier to use. Publication(s): *Technometrics*, Vol. 28, No. 1, (1986), pp. 18.
3. T	**Analysis of Unreplicated Factorials Allowing for Possibly Faulty Observations** by George Box and R. Daniel Meyer, (February 1986). Inaccurate data points are particularly troublesome in the analysis of unreplicated factorial experiments, but new techniques allow investigators to overcome this difficulty. Publication(s): *Design, Data, and Analysis*, Colin Mallows (ed.), Wiley, (1987), pp. 12.
4. MG	**Managing Our Way to Economic Success: Two Untapped Resources** by William G. Hunter,(February 1986). American organizations could compete much better at home and abroad if they would learn to tap the potential information inherent in all processes and the creativity inherent in all employees.
5. MG	**My First Trip to Japan** by Peter R. Scholtes, (February 1986). American visitors to Japan can learn much about what it takes to successfully implement quality improvement.

6. MG **Total Quality Leadership vs. Management by Control** by Brian L. Joiner and Peter R. Scholtes, (February 1988). To survive in increasingly tough markets, top management in American companies will have to forsake their desire to "control" their employees, and instead learn what it means to provide Total Quality Leadership.

7. T **Studies in Quality Improvement: Designing Environmental Regulations** by Søren Bisgaard and William G. Hunter, (February 1986). There is a surprising similarity between what SPC provides for industries and the need for constructing sensitive, reliable standards for environmental regulations. Conference Proceeding: ASA/EPA Conference on Interpretation of Environment Data, IV Compliance Sampling, Paul I. Feder, editor, 1987.

8. T **Studies in Quality Improvement: Minimizing Transmitted Variation by Parameter Design** by George Box and Conrad A. Fung, (February 1986). By properly designing products and taking the inevitable variation in components into account, engineers can minimize the amount of variation that ultimately shows up in finished products. Publication(s): Accepted by *Journal of Quality Technology*.

9. T **A Useful Method for Model Building II: Synthesizing Response Functions from Individual Components** by William G. Hunter and Andrzej P. Jaworski, (February 1986). Analyzing which components of a response are due to each factor is an alternative way to find the best model for studying the properties of a product or process (and thus for improving both). Publication(s): *Technometrics*, Vol. 28, No. 4, November (1986), pp. 321-327.

10. T **The Next 25 Years in Statistics** by William J. Hill and William G. Hunter (With contributions by Joseph W. Duncan, A. Blanton Godfrey, Brian L. Joiner, Gary C. McDonald, Charles G. Pfeifer, Donald W. Marquardt, and Ronald D. Snee), (February 1986). A transformation of the American style of management has already begun; in order for it to succeed, statisticians must assume a leadership role. Publication(s): *Chance* 1990, No. 1, pp. 38-39.

11. T **Signal to Noise Ratios, Performance Criteria and Statistical Analysis: Part I** by George Box. Signal to noise ratios have been used to identify what combination of factors can actually produce the desired product characteristics with the minimum amount of dispersion (variance), but it turns out that these measures are dependent on how the data are transformed. (This report, along with Report 12, is no longer in print. A combination and extension of Reports 11 and 12 now appear as Report 26.)

12. T **Signal to Noise Ratios, Performance Criteria and Statistical Analysis: Part II** by George Box and José Ramírez. Many of the criteria being used to measure performance of a process have hidden biases and inadequacies, but there are techniques that avoid these pitfalls. (This report along, with Report 11, is no longer in print. A combination and extension of Reports 11 and 12 now appear as Report 26.)

13. MG **Doing More With Less in the Public Sector: A Progress Report from Madison, Wisconsin** by William G. Hunter, Jan O'Neill, and Carol Wallen, (June 1986). The new quality improvement ideas can help public officials combat the effects of decreasing budgets just as they help private businesses increase productivity. Publication(s): **Quality Progress**, July 1987, pp. 19-26.

14. MG **Drastic Changes for Western Management** by Edwards Deming, (June 1986). This report is a compact summary of the most important points that Dr. W. Edwards Deming has been making about changes that must be made by American businesses if they are to be competitive.

15. MG **How to Apply Japanese Company-Wide Quality Control in Other Countries** by Kaoru Ishikawa, (November 1986). This report highlights the experiences of Kaoru Ishikawa, a leader in Japan's QC movement, who has spent the last 20 years visiting countries all over the world to give lectures and guidance on QC implementation. Publication(s): *Quality Progress*, September 1989, Vol. 22, No. 9, pp. 70-74.

16. MG **Analysis of Factional Factorials** by R. Daniel Meyer, (June 1986). Statistically designed experiments, particularly fractional factorial designs, are key tools to use when the object is to screen a large number of variables in order to identify those with the most influence.

17. MGS **Eliminating Complexity from Work: Improving Productivity by Enhancing Quality** by F. Timothy Fuller, (July 1986). Increasing quality does not increase costs; in fact, it is poor quality that increases "complexity," which in turn increases cost and decreases productivity. Publication(s): *National Productivity Review*, Autumn, 1985.

18. MG **The World Class Quality Company** by William A. Golomski, (December 1986). Through a long history of consulting with companies around the world, William Golomski has found some themes common to companies capable of achieving world class quality.

19. T **An Investigation of the Method of Accumulation Analysis** by George Box and Stephen Jones, (December 1986). A discussion of Taguchi's method for analyzing ordered categorical data. Publication(s): Technometrics, November 1986, Vol. 28, No. 4, pp. 295-301 and also in *Total Quality Management* 1990, Vol. 1, No. 1.

20. T **A Critical Look at Accumulation and Related Methods** by Mike Hamada and C. F. Jeff Wu, (November 1986). Using accumulation analysis on ordered categorical data can often result in the detection of spurious effects. Publication(s): *Technometrics* 1990, Vol. 32, No. 2, pp. 119-162.

21. MG **A Process for Consulting for Improvement in Quality and Productivity** by Spencer Graves,(November 1986). A process that consultants can use to improve their effectiveness.

22. T **Further Details of an Analysis for Unreplicated Fractional Factorials** by R. Daniel Meyer, (February 1987). Some important implications and statistical details of Box and Meyer's formal approach to the analysis of unreplicated fractional factorial experiments.

23. T **Identification of Active Factors in Unreplicated Fractional Factorial Experiments** by R. Daniel Meyer and George Box, (February 1987). How to pinpoint the most likely explanation for the results of unreplicated fractional factorial experiments.

24. T **An Investigation of OA-based Methods for Parameter Design Optimization** by C. F. J. Wu, S. S. Mao, and F. S. Ma, (April 1987). There exists simpler alternatives for analyzing the results of a designed experiment than the orthogonal array methods proposed by Taguchi. Publication(s): Appeared in *Collection of Works* by Subir Ghost 1990.

25. TG **The Scientific Context of Quality Improvement** by George Box and Søren Bisgaard, (September 1987). Scientific method is a key ingredient in the new philosophy of quality and productivity improvement. This paper provides an overview. A discussion of new ideas of how to design quality into products and processes is provided and Taguchi's work is evaluated and put in context. Publication(s): *Quality Progress*, (1987), pp. 54-62.

26. T **Signal to Noise Ratios, Performance Criteria and Transformation** by George Box, (July 1987). The relevance, efficiency and relation to transformations of Taguchi's signal to noise ratios are critically discussed. (This report is a combination and extension of Reports 11 and 12.) Publication(s): *Technometrics*, Vol. 30, No. 1, (1988), pp. 1-17.

27. MG **On Quality Practice in Japan** by George Box, Raghu Kackar, Vijay Nair, Madhav Phadke, Anne Shoemaker, and C. F. Jeff Wu, (December 1987). This report contains a summary of impressions from a study mission to Japan by a researcher from AT&T Bell Laboratories and the Center for Quality and Productivity Improvement, University of Wisconsin. It describes important quality initiatives seen in Japan and provides a comparative analysis between the United States and Japan. Publication(s): *Quality Progress*, March 1988, pp. 37-41.

28. TG **An Explanation and Critique of Taguchi's Contributions to Quality Engineering** by George Box, Søren Bisgaard, and Conrad Fung, (March 1988). This paper presents an overview of Professor Genichi Taguchi's contributions and concludes that Professor Taguchi's quality engineering ideas are of great importance. However, many of the statistical design and analysis techniques he employs are often inefficient and unnecessarily complicated and should be replaced or appropriately modified. Publication(s): *Quality and Reliability Engineering International*, Vol. 4, No. 2, (1988), pp. 123-131.

29. T **Analysis of Incomplete Data from Highly Fractionated Experiments** by Michael Hamada and C. F. Jeff Wu, (April 1988). An iterative method is proposed that provides a simple and flexible way to consider many models simultaneously. The method can be implemented with existing software, results in computational savings and promotes experimenter involvement. Publication(s): *Technometrics* 1991,Vol. 33, No. 1, pp. 25-38.

30. T **Discriminant Upset Analysis** by Paul M. Berthouex, George Box, and Agustinus Darjatmoko, (May 1988). This report presents an application of discriminant analysis in setting rules for early warning indicators of process upsets in wastewater treatment plant operation.

31. G **Quality Improvement: An Expanding Domain for the Application of Scientific Method** by George Box, (July 1988). Sir Ronald Fisher's work on data analysis and experimental design made possible applications of scientific method to quality improvement in industry and everyday life. This paper discusses how quality improvement provides an expanding domain for scientific method. Publication(s): *Philosophical Transactions of the Royal Society (1989)*, "Industrial Quality and Reliability", pp. 139-152.

32. GS **The Quality Detective: A Case Study** by Søren Bisgaard, (June 1988). A case study is presented that illustrates the practical problems of conducting experiments in an industrial environment. Publication(s): *Philosophical Transactions of the Royal Society (1989)*, "Industrial Quality and Reliability" pp. 21-32.

33. T **A Contour Nomogram for Designing Cusum Charts for Variance** by José Ramírez and Jesús Juan,(February 1989). A contour nomogram is given that helps in the design of cumulative sums charts for variance when the observations are normally distributed.

34. MG **When Murphy Speaks — Listen** by George Box, (February 1989). Every operating system supplies information on how it can be improved but this information is often not acted on because people believe they are powerless to alter the system. The needed change in management philosophy and the necessity of input from those closest to the system is discussed. Three strategies for system improvement — corrective feedback, preemptive feedforward and simplification are described. Publication(s): *Quality Progress*, Vol. 22, No. 10, October (1989), pp. 79-84.

35. GS **The Necessity of Modern Quality Improvement and Some Experience with its Implementation in the Manufacture of Rolling Bearings** by C. Hellstrand, (March 1989). SKF restructured its manufacturing world-wide in response to competition from Japan in the early 1970s. The necessity of a company-wide quality procedure soon became evident. Its implementation later paved the way for both the implementation of statistical process control (SPC) and of experimental design throughout the company. Topics discussed include the structure of SKF quality procedures, difficulties and benefits experienced while implementing SPC and experimental design throughout the organization. Publication(s): *Philosophical Transactions of the Royal Society (1989)*, "Industrial Quality and Reliability", pp. 51-56.

36. G **Quality in the Community: One City's Experience** by George Box, Laurel W. Joiner, Sue Rohan, and F. Joseph Sensenbrenner, (June 1989). This report highlights the evolution of the quality movement in Madison, Wisconsin, and addresses what it takes to start a quality improvement network or similar organization. Publication(s): Accepted in *Quality Progress*.

37. TS **Case Study: Experimental Design in a Pet Food Manufacturing Company** by Albert Prat and Xavier Tort, (October 1989). Experimentation in the complex world of industry and service organizations requires a deep understanding of the basic engineering concepts underlying the process being studied, as well as relevant technical and economic constraints. The experimental design described in this report is a plant experiment where those constraints were taken into account. Several responses were measured, for the goal was not only to improve quality but also to increase productivity and reduce cost.

38. G **Teaching Statistics to Engineers** by Søren Bisgaard, (October 1989). The fact that many engineers have only recently "discovered" statistics suggests that we need to reconsider our approach to teaching this important science. In this report, Søren Bisgaard reports on his experience teaching engineers using an approach that integrates statistics into engineering practice. Publication(s): *The American Statistician*, November 1991, Vol. 45, No. 4, pp. 274-283.

39. T **Integration of Techniques in Process Development** by George Box, (January 1990). The reasons for the need of an iterative approach to experimentation are explained. The consequent implications in the use of screening designs (fractional factorials and other orthogonal arrays), response surface designs and mechanistic modeling studies are discussed. Publication(s): *Transactions of the 11th Annual Convention of the American Society for Quality Control*, (1957). pp. 687-702.

40. TG **Quality Engineering and Taguchi Methods: A Perspective** by Søren Bisgaard, (January 1990). Robust product design and parameter design — methods to develop products that will perform well regardless of changes in uncontrollable environmental conditions or that are insensitive to component variation — are key concepts in the work of Dr. Taguchi. We should encourage design and manufacturing engineers to apply these useful ideas. But in designing experiments and analyzing data aspects of the practical implementation — better and simpler methods are available and should be preferred over Taguchi's less intuitive and more cumbersome approaches. Publication(s): *Target*, October (1989), pp. 13-19.

41. T **Statistical Process Control and Automatic Process Control — A Discussion** by George Box and Tim Kramer, (January 1990). The roles of Statistical Process Control for process monitoring and of Automatic Process Control for process regulation are considered and common misunderstandings discussed. Simple examples are used to show how the characteristics of the disturbance affecting the system, of the process dynamics and of various costs, decide the nature of optimal control schemes. Publication(s): *Technometrics*. Vol. 34, No. 3, August 1992. pp. 251-285.

42. T **Process Control From An Economic Point of View — Chapter 1: Industrial Process Control** by Tim Kramer, (February 1990). Some of the issues mentioned in technical Report #41 concerning the proper uses of Statistical Process Control and Automatic Process Control are discussed in greater detail in this report.

43. T **Process Control From An Economic Point of View - Chapter 2: Fixed Monitoring and Adjustment Costs** by Tim Kramer, (February 1990). The problem of choosing a control scheme that minimizes the combined costs of monitoring, adjustment and being off target is discussed. In addition to the various costs, the choice depends on the nature of the disturbance and the dynamic relationship between control actions and their effects.

44. T **Process Control From An Economic Point of View — Chapter 3: Dynamic Adjustments and Quadratic Costs and Chapter 4: Summary and Future Research** by Tim Kramer, (February 1990). When a process is such that there is appreciable delay in control action taking effect, minimal variance feedback control can require excessive adjustment. In this report it is supposed that the cost of making the adjustments is proportional to the square of the size of the adjustment and the minimal cost schemes that result are considered. These "damped" schemes are compared with minimum mean square error schemes which use a longer monitoring interval.

45. TS **An Application of Taguchi's Methods Reconsidered** by Veronica Czitrom, (July 1990). Two aspects of Taguchi's methods for analyzing parameter design experiments that can be improved upon are considered. It is shown how using interaction graphs instead of marginal graphs, and how using the sample variance instead of a signal-to-noise ratio, can lead to product designs that are more robust to variation. The advantages of the alternative analysis will be illustrated by re-analyzing a case study considered by Barker (1986). Presented at the ASA Meeting, Washington, DC, 1989.

46. TG **Do Interactions Matter?** by George Box, (November 1989). It has recently been argued that in an industrial setting the detection and elucidation of interactions between variables is unimportant. In this report contrary view is advanced and is illustrated with examples. Publication(s): *Quality Engineering* 1990, Vol. 2, No. 3, pp. 365-369.

47. TG **Must We Randomize Our Experiment?** by George Box, (December 1989). The importance of randomization in the running of valid experiments in industrial context is sometimes questioned. In this report the essential issues are discussed and guidance is provided. Publication(s): *Quality Engineering* 1990, Vol. 2, No. 4, pp. 497-502.

48. TG **Good Quality Costs Less? How Come?** by George Box, (March 1990). It is sometimes supposed that the manufacture of high quality goods must be expensive. The reasons why this need not be so and why quality should cost less are discussed. Publication(s): *Quality Engineering* 1990-91, Vol. 3, No. 1, pp. 85-90.

49. TM **Design of Standards and Regulations** by Søren Bisgaard, (February 1990). This report outlines how statistical terminology, concepts and methods can help in the design of better specifications of laws and standards. Publication(s): *Journal of the Royal Statistical Society 1991*, Series A 154, Part I, pp. 93-96.

50. S **An Application of Box — Jenkins Methodology to the Control of Gluten Addition in a Flour Mill** by T. Fearn and P. I. Maris, (August 1990). The approach of Box and Jenkins was used to design a control algorithm for a feedback loop controlling the addition of dried gluten to bread making flour in a four mill. The variations to be controlled were modelled by an IMA (0,1,1) process and the system dynamics identified as a simple delay. The resulting optimal control strategy was implemented and worked well.

51. T **Existence and Uniqueness of the Solution of the Likelihood Equations for Binary Markov Chains** by Søren Bisgaard and Laurel E. Travis, (December 1990). The two-state Markov chain is a useful model when analyzing binary data that may be serially correlated. The likelihood equations for this model are two intersecting conics, and several solutions could be anticipated. However, we prove the existence and uniqueness of the solution, and give a simple method for numerical solution. Publication(s): *Statistics and Probability Letters*, 1991, Vol. 12, No. 1, pp. 29-35.

52. S **Quality Improvement Approaches for Chemical Processes** by William J. Hill and Lane Bishop,(August 1990). Quality improvement of chemical processes through the use of design of experiments (DOE), variance component analysis, and process noise simulation models is the focus of this report. A case history of a nylon process serves as the backdrop as to how effective these "second generations" tools can be in the process industries. The memory of Dr. William G. Hunter and his philosophy provide the central theme and message for the discussion. Publication(s): *Quality Engineering* 1990-91, Vol. 3, No. 2, pp. 137-152.

53. T **Constrained Experimental Designs Part I: Construction of Projection Designs** by Ian Hau and George Box, (October 1990). Experimental design is a powerful tool for quality improvement. In some situations, however, the design variables are subject to multiple linear constraints. In this report, we propose a class called *projection designs* which can be used when the design variables are constrained by linear relations. Fundamental issues such as region of interest and scaling of design variables are discussed. Then the construction of projection designs are illustrated.

54. T **Constrained Experimental Designs Part II: Analysis of Projection Designs** by Ian Hau and George Box, (October 1990). In this report, we discuss the analysis of projection designs proposed in Report #53. We show that analyzing projection designs is essentially the same as analyzing some traditional unconstrained designs such as factorial designs and composite designs.

55. T **Constrained Experimental Designs Part III: Steepest Ascent and Properties of Projection Designs** by Ian Hau and George Box, (October 1990). Steepest ascent is an important tool for process improvement. This report discusses how to use the steepest ascent method in the context of constrained designs. The properties of the projection designs proposed in Report #53 are also discussed.

56. T **Designing Products That Are Robust To The Environment** by George Box and Stephen Jones, (March 1990). Professor Genichi Taguchi has emphasized the use of designed experiments in several novel and important applications. The engineering concept of robust product design is important since it is frequently impossible or prohibitively expensive to control or eliminate sources of variation due to environmental conditions. In robustness experiments, Professor Taguchi's total experimental arrangement consists of a cross-product of two experimental designs, an inner array containing the design factors and an outer array containing the environmental factors. Except in situations where both of these arrays are small, this arrangement may involve a prohibitively large amount of experimental work. One of the objectives of this report is to show how this amount of work can be reduced. Publication(s): *Total Quality Management*, 1992, Vol. 3, No. 3, pp. 3-26

57. TG **A Simple Way to Deal With Missing Observations From Designed Experiments** by George Box, (September 1990). A common difficulty in using designed experiments is that for one reason or another certain observations may be missing. This article discusses a simple way due to Draper and Stoneman to deal with this problem for two level factorials and fractional factorials. Some broader philosophical issues concerning missing observations are also discussed. Publication(s): *Quality Engineering* 1990-91, Vol. 3, No. 2, pp. 249-254.

AND

Finding Bad Values in Factorial Designs by George Box, (September 1990). Sometimes the results from a designed experiment contain "bad or suspect" values. This article discusses a simple way due to Cuthbert Daniel of detecting a bad value. It also describes how you might re-estimate its value. More general issues are considered surrounding observations that appear discrepant. Publication(s): *Quality Engineering* 1990-91, Vol. 3, No. 3, pp. 405-410.

58. T **Cumulative Score Charts** by George Box and José Ramírez, (February 1991). In this paper we develop Cuscore statistics for this purpose which can be used as an adjunct to the Shewhart chart. These statistics use an idea due to Box and Jenkins (1966) which is in turn an application of Fisher score statistic. We show how the resulting procedures relate to Wald-Barnard sequential tests and to Cusum statistics which are special cases of Cuscore statistics. The ideas are illustrated by a number of examples. These concern the detection in noisy environment of (a) an intermittent sine wave, (b) a change in slope of a line, (c) a change in an exponential smoothing constant, and (d) a change from a stationary to a non-stationary state in a process record. Publication(s): *Quality and Reliability Engineering*, January 1992, Vol. 8, pp. 17-27.

59. MGS **Teaching Quality Improvement by Quality Improvement in Teaching** by Ian Hau, (February 1991). In response to disturbing challenges ahead, leaders at the University of Wisconsin-Madison are committed to transform the institution to a Total Quality University. As a pilot project in the transformation, this paper describes how students and the instructor worked as a team to improve the quality of teaching in a class. Treating students as *customers*, the team identified 50 areas that affected the quality of teaching. A class survey revealed six areas where most students indicated problems. The instructor then implemented changes which dramatically reduced the *defect* rate as viewed by the customers in these areas. For example, the defect rate dropped from 78% to 22% for computer instruction, 56% to 8% for blackboard presentation, and 82% to 20% for overhead presentation. The team also developed a system to transfer their knowledge to the next team to ensure never-ending improvement in the future.

60. T **An Analysis of Taguchi's Method of Confirmatory Trials** by Søren Bisgaard and Neil Diamond, (October 1990). Taguchi has suggested a new method of confirmatory trials that is intended to test for possible interactions effects. The method is being promoted by many recent authors. A careful analysis of this method, however, shows that confirmatory trials are ineffective in detecting the presence of interaction effects. In fact in many cases, it is shown that the probability of detecting an interaction effect decreases rather than increases as the size of the interaction effect increases. Thus, we advice practitioners not to adopt this new method as a test for interactions.

61. T **Split-Plot Designs for Robust Product Experimentation** by George Box and Stephen Jones, (May 1990). More details of the issues in Report 56 are discussed in this report. Consideration of the efficiency of split-plot designs indicates that experiments conducted in a split-plot mode can be of tremendous value in robust product design since they not only enable the contrasts of interest to be estimated efficiently but also the experiments can be considerably easier to conduct than the designs proposed by Professor Taguchi. Publication(s): *Journal of Applied Statistics*, 1992, Vol. 19, No. 1, pp. 3-26.

62. T **Robust Product Designs, Part I: First-Order Models with Design × Environment Interactions** by George Box and Stephen Jones, (May 1990). In this paper we apply the strategy developed in Report 56 to a simple first-order model with interactions between the design and the environmental factors. For this model we derive the robustness measure and give a series of tables of designs that are appropriate for the possible objectives of the experimenter.

63. T **Robust Product Designs, Part II: Second-Order Models** by George Box and Stephen Jones, (May 1990). In this paper we apply the strategy developed in Report 56 to a general second-order model. For this model we derive the robustness measure and give a series of tables of designs that are appropriate for the possible objectives of the experimenter.

64. T **Robust Product Designs, Part III: Second-Order Models with Additional Third-Order Terms** by George Box and Stephen Jones, (May 1990). In this paper we apply the strategy developed in Report 56 to a general second-order model with additional third-order terms. For this model we derive the robustness measure and give a series of tables of designs that are appropriate for the possible objectives of the experimenter.

65. T **Sequential Methods in Statistical Process Monitoring, Chapter 1: Introduction and Chapter 2: Sequential Monitoring of Variances** by George Box and José Ramírez, (May 1991). A CUSUM chartto monitor variability, based on the Wald-Barnard likelihood ratio test, is introduced. A nomogram to aid in the construction of the charts is also presented.

66. T **Sequential Methods in Statistical Process Monitoring, Chapter 3: Design of CUSUM Charts** by George Box and José Ramírez, (May 1991). In this report we show how to design CUSUM charts to monitor process variability. An eight step outline for the implementation of these charts is included.

67. T **Sequential Methods in Statistical Process Monitoring, Chapter 4: Sequential Monitoring of Models, Chapter 5: Summary and Future Research, and Appendix: Table of ARL Values** by George Box and José Ramírez, (May 1991). An extension of the cumulative sum charts based on the Fisher's score function is introduced. This CUSCORE can be used to monitor parameter changes in a model. It is shown that the traditional CUSUM for location is a particular case of the CUSCORE.

68. TM **A Simple Rule for Judging Compliance Using Highly Censored Samples** by P. M. Berthouex and Ian Hau, (April 1991). A special case of judging compliance is when the effluent limit is set at a level below the method limit of detection (MDL) of the substance being monitored. In many such cases, almost all measurements on the effluent are reported as "not detected." A simple rule is proposed for judging compliance of the effluent in this situation. It makes allowance for random errors in measurements on the effluent and it recognizes that an effluent can be in compliance and still produce a proportion of values above the MDL.

69. MG **Quality Improvement at the Design Stage — *A Cyclic Incremental Approach*** by Søren Bisgaard, (May 1991). Quality control based on inspection and segregation is uneconomical and inefficient. To be effective, quality needs to be considered and planned at the product design stage. In this article we put what seems like detailed problem solving, troubleshooting and statistical experimental design work into the larger context of the design and product development process. To do this we have developed a conceptual model for the design process based on the idea of cyclic incremental improvement. Proceedings of the 17th NSF Design and Manufacturing Systems Grantees Conference, University of Texas, Austin, January 1991.

70. TG **Process Optimization — Going Beyond Taguchi Methods** by Søren Bisgaard, (May 1991). This paper summarizes a speech given at the May 25, 1990 National Thermal Spray Conference in Long Beach, California. It is an expository paper which motivates the use of RSM for Product and Process Improvement and the sequential approach to experimentation with Taguchi methods. Proceedings of the 3rd National Thermal Spray Conference, Long Beach, California.

71. TG **Understanding Exponential Smoothing — A Simple Way to Forecast Sales and Inventory** by George Box, (April 1991). This article gives a simple account of exponential smoothing and the way it can be used in forecasting. The meaning of an exponentially weighted moving average (EWMA) is given and the role of the smoothing constant in balancing the need to average data against the need for immediacy in the forecast is discussed. A way of estimating the smoothing constant is presented. Publication(s): *Quality Engineering* 1990-91, Vol. 3, No. 4, pp. 561-566.

AND

Feedback Control by Manual Adjustment by George Box, (April 1991). While we should always make a dedicated endeavor to bring a process into a state of control by fixing causes of variation, there sometimes remains a tendency for the process to wander from the target. In such a case, some method of feedback adjustment may be needed. This article discusses an easily used manual feedback adjustment chart which is equivalent to integral control used by the control engineer. Publication(s): *Quality Engineering* 1991-92, Vol. 4, No. 1, pp. 143-151.

AND

Bounded Adjustment Charts by George Box, (April 1991). The feedback adjustment charts discussed in the previous article are valuable when the cost of adjustment is essentially zero. However, when process adjustment is associated with a specific cost (for example, of stopping a machine and changing a tool), it is more economical to use a scheme that requires less frequent adjustment. For this purpose, bounded adjustment charts using an exponentially weighted average of past data may be used. A simple interpolation chart is presented for updating the forecast and indicating when and how large an adjustment is needed. A table is given allowing a scheme to be chosen by balancing a longer average interval between adjustments against the resulting increase in the standard deviation about the target value. Publication(s): *Quality Engineering* 1991-92, Vol. 4, No. 2, pp. 331-338.

72. T **A Method for the Identification of Defining Contrasts for 2^{k-p} Designs** by Søren Bisgaard, (July 1991). The defining relation for a two-level fractional factorial design uniquely characterizes a design; from it the design can be studied, all the aliases can be found, the resolution determined, and the design if necessary reproduced. Finding a set of generators which is the key to finding the defining relation for a given two-level fractional factorial design is, however, usually a tedious job. In this article an algebraic method is presented that simplifies this job. Publication(s): To appear in *Journal of Quality Technology*.

73. GS **The Use of Statistics to Improve Manufacturing Systems** by Søren Bisgaard, (October 1991). This article presents a general overview of statistical methods applied to solving manufacturing problems. We also provide a specific example of a statistically designed experiment used to study factors affecting robot accuracy. The robot experiment illustrates how manufacturing engineers can improve quality and productivity, and reduce costs by applying relatively simple statistical tools on the shop floor. Publication(s): to appear in *Manufacturing Review*

74. MG **Quality Improvement — The New Industrial Revolution** by George Box, (October 1991). Beginning from Bacon's famous aphorism that "Knowledge Itself is Power", the underlying philosophy of modern quality improvement is seen as the mobilization of presently available sources of knowledge and knowledge gathering. These resources, often untapped include the following: (i) that the whole workforce possesses useful knowledge and creativity; (ii) that every system by its operation produces information on how it can be improved; (iii) that simple procedures can be learned for better monitoring and adjustment of processes; (iv) that elementary principles of experimental design can increase the efficiency many times over of experimentation for process improvement, development, and research. Publication(s): to appear in *International Statistical Institute Journal.*

75. G **The Early Years of Designed Experiments In Industry: Case Study References and Some Historical Anecdotes** by Søren Bisgaard, (November 1991). Case studies are important because they provide illustrations of the industrial use of designed experiments. However, they are usually hard to come by; nevertheless unknown to many, there are quite a few case studies already published in the literature. Most of them are unfortunately scattered in many different technical and scientific journals, and are not readily available unless one knows where to look. In this article we provide a list of approximately 130 references to case study articles published over the past six decades. We also provide a causerie of historical anecdotes from early initiatives in the use of designed experiments in industry. Publication(s): *Quality Engineering* 1992. Vol. 4, No. 4, pp. 547-562.

76. TG **Teaching Engineers Experimental Design With a Paper Helicopter** by George Box, (November 1991). How a paper "helicopter" made in a minute or so from a 8 1/2" × 11" sheet of paper can be used to teach principles of experimental design including conditions for validity of experimentation, randomization, blocking, the use of factorial and fractional factorial designs, and the management of experimentation. Publication(s): *Quality Engineering* 1992, Vol. 4, No. 3, pp. 453-459.

77. T **Blocking Generators for Small 2^{k-p} Designs** by Søren Bisgaard, (January 1992). Small 2^{k-p} designs are increasingly being used in industry for processes and product experimentation. Blocking of these designs can often significantly increase their efficiency, but does not seem to be its full potential in industry. To facilitate the practical use of blocking, a comprehensive table providing information about blocking generators for all the possible eight and sixteen runs, two-level fractional factorial designs has been developed. Examples of blocking and application of the table are also provided. Publication(s): To appear in *Journal of Quality Technology*.

AND

A Note on the Definition of Resolution for Blocked 2^{k-p} Designs by Søren Bisgaard, (May 1992). When 2^{k-p} designs are blocked, the application of the standard definition of resolution requires careful consideration. The problem is that the degrees of freedom associated with a set of blocking contrasts are essentially all "first order effects." Hence contrasts that superficially may appear as higher order interaction effects in reality are first order effects. Experimenters might therefore inadvertently confound these first order effects with important effects among the primary factors. In this note we discuss this subtle problem and provide an additional rule to the usual definition of resolution that helps provide a conservative but more realistic estimate of the resolution of a blocked design. We also show that this amendment to the definition is useful when several two-level contrasts are combined to yield factors with more than two levels. A few illustrative examples are provided.

78. TG **What Can You Find Out From Eight Experimental Runs?** by George Box, (February 1992). Publication(s): Quality Engineering 1992, Vol. 4, No. 4, pp. 619-627 and also to appear in *Journal of Quality Technology* and also to appear in *Technometrics*.

AND

What Can You Find Out From Sixteen Experimental Runs? by George Box, (February 1992). Publication(s): To appear in Quality Engineering. Different ways to use $n = 8$ and $n = 16$ experimental runs are described to generate two level factorial and fractional factorial designs for studying up to $n - 1$ factors. The roles of "aliases" and of design "resolution" are discussed and the rationales for the employment of designs with different degrees of fractionation are presented.

79. T **Taguchi's Parameter Design: Panel Discussion** edited by Vijayan N. Nair with discussants B. Abraham, G. Box, R. Kacker, T. Lorenzen, J. Lucas, J. MacKay, R. Myers, J. Nelder, M. Phadke, J. Sacks, A. Shoemaker, S. Taguchi, K. Tsui, G. Vining, W. Welch, and J. Wu (March 1992). It is more than a decade since Genichi Taguchi's ideas on quality improvement were introduced in the U.S. His parameter design approach for reducing variation in products and processes has generated a great deal of interest and debate among both quality practitioners and statisticians. This panel discussion provides a forum for a *technical* discussion of these diverse views. The topics discussed include the importance of variation reduction, the use of noise factors, the role of interactions, selection of quality characteristics, signal-to-noise (SN) ratios, experimental strategy, dynamic systems, and applications. The discussion also provides an up-to-date overview of recent research on alternative methods of design and analysis. Publication(s): *Technometrics*. Vol. 34, No. 2 May 1992, pp. 127-161.

80. T **Finding the Active Factors in Fractionated Screening Experiments** by R. Daniel Meyer and George Box, (April 1992). Highly fractionated factorial designs and other orthogonal arrays are powerful tools for identifying important, or active, factors, and improving quality. We show, however, that interactions, and important factors involved in those interactions, may go unidentified when conventional methods of analysis are used with these designs. This is particularly true of Plackett and Burman designs with number of runs not a power of two. A Bayesian method is developed in which the marginal posterior probability that a factor is active is computed, and allows for the possibility of interactions. The method can be applied to both orthogonal and nonorthogonal designs, as well as other troublesome situations, such as when data are missing, extra data are available, or factor settings for certain runs have deviated from those originally designed. The value of the new technique is demonstrated with three examples in which potential interactions and factors involved in those interactions are uncovered. Publication(s): to appear in *Journal of Quality Technology*.

81. MG **A New Design for Quality Paradigm** by Mikkel Mørup (April 1992). Product development and design has a tremendous influence on the final product quality and the cost of quality. This paper presents a critical look at the position of Design for Quality in western industry and academia. It is suggested that Design for Quality should be enhanced in the context of design methodology in order to better fit the way that products are actually designed. Finally, the paper presents new concepts, models and a structured procedure for Design for Quality that have evolved by looking at quality from the viewpoint of design methodology. Publication(s): *Journal of Engineering Design* (1992). Vol. 3, No. 1. pp. 63-80.

82. T **A Comparative Analysis of the Performance of Taguchi's Linear Graphs** by Søren Bisgaard, (June 1992). In this article we use conventional concepts of aliasing and confounding to analyze several two-level fractional factorial designs constructed with the use of Taguchi's linear graph technique. We also compare these designs with more conventional alternatives and show that the conventional design are often better in terms of resolution, and are robust to assumptions that are likely to be violated in practice. We also comment on the practice of making strong prior assumptions based on engineering knowledge about which two-factor interactions are active and which are inert. We conclude that the value of linear graphs is limited, that the designs obtained are non-robust, and that better and simpler conventional alternatives already exist.

83. TG **Sequential Experimentation and Sequential Assembly of Designs** by George Box, (June 1992). Because of the many uncertainties in choosing an appropriate experimental design, it is best to avoid "all encompassing" experiments which must necessarily be planned when least is known about the system. Instead, where possible, it is best to run smaller sets of experiments in sequence. Examples are given of how a strategy of "sequential assembly" of design can be used. Publication(s): to appear in *Quality Engineering*

84. TG **How to Get Lucky** by George Box, (June, 1992). Some principles for success in quality improvement projects discuss, in particular, how to encourage the discovery of useful phenomena not initially being sought. A graphical version of the analysis of variance which can help to show up the unexpected is illustrated with two examples. Publication(s): to appear in *Quality Engineering*.

85. T **Comparison of Two Approaches for Feedback Control** by Alberto Luceño, (July 1992). Two forms of feedback regulation that have been used for process adjustment in Automatic Process Control are considered. In the first, recommended originally by Box and Jenkins (1963) and by Box, Jenkins and MacGregor (1974), action is taken when the absolute difference between an exponentially weighted moving average (EWMA) of the past data $\hat{z}$ and the target value T first crosses a threshold value L^*. In the second, recommended by Taguchi (1981), the action is triggered when the absolute difference between the last observation z_n and the target value T exceeds a given constant l. It has been shown (Box and Jenkins (1963)) that if we consider the disturbance as an integrated moving average IMA (0,1,1) model containing parameter θ, then the former is optimal when θ is equal to the smoothing parameter used in the EWMA, and the latter is optimal if θ is zero. Thus some controversy has arisen because, as we show here, for any given scheme of the second kind with parameter L, there is a scheme of the first kind with boundary L^* which for a single crossing of the boundaries gives the same overall cost. However, because the adjustment is in once case based on the deviation from target of the EWMA $\hat{z}$ and in the other on the deviation of the observation $\hat{z}$, and it can be shown that = $\hat{z}$, where a_n is a random variable independent of $\hat{z}$, the actual cost of regularly applying the policy based on z_n is considerably more expensive than that based on $\hat{z}$ For example, in practice θ is frequently in the range from about 0.6 to about 0.9 and it is shown here that an increase in the mena square deviation of 64% can occur with $\theta = 0.8$. Publication(s): to appear in *Communications in Statistics*.

86. T **An Iterative Non-Graphical Approach to Accommodate Interactions for Two-level Fractional Factorials** by Søren Bisgaard and Howard Fuller, (July 1992). Taguchi and Wu (1985) introduced the method of linear graphs to accommodate pre-specified interaction effects in orthogonal arrays. However, it has been known for some time that Taguchi's method when applied to two level fractional factorial designs often leads to experiments that have lower resolution than need be. Lately several alternative methods for accommodating interaction effects using graphs have been proposed. Kacker and Tsui (1990) developed a method called interaction graphs and Wu and Chen (1992) proposed another graph-aided method that optimizes resolution by minimizing aberration subject to the requirement that all the specified main effects and interactions are estimable. Instead we propose to maximize the accommodation of specified interaction effects subject to the constraint of allowing only maximum resolution designs. We also present a simple approach based on iterative substitution, easily implemented with commercially available word processing software, which guarantees a maximum resolution solution to the accommodation problem.

87. T **Experimental Optimization of Computer Models** by Søren Bisgaard, Bruce Ankenman and Tim A. Osswald. Reducing the time and cost of product and process development is a key concern of today's competitive industrial firms. Although engineers often have available complex computer models of the product or process being developed, the use of these simulation models is often limited to ad hoc, one-factor-at-a-time exploration. In this article, a compression molding example is used to demonstrate a sequential strategy for optimizing complex computer simulation models based on response surface methodology. It is explained how the use of this approach can reduce the time and cost of prototype building and testing and thus aid in reducing the development time and cost.

University Practice of Total Quality Working Council

Working Council Membership

Co-Chairs

L. Edwin Coate
Vice President for Finance and Administration, Oregon State University/ University of California - Santa Cruz

John A. Brighton
Executive Vice President and Provost of the University, The Pennsylvania State University

Members

Ellen E. Chaffee
Vice Chancellor for Academic Affairs, North Dakota University System

Carol Tyler
Quality Instructor, Fox Valley Technical College

Gilbert R. Whitaker, Jr.
Provost and Vice President for Academic Affairs, The University of Michigan

Jill Maser
Quality Coordinator, University of Pennsylvania

Carol Mishler (Survey Assistant)
Manager, Project & Research Services, Fox Valley Technical College

Contents

Introduction

Academic Emergence into TQ

The Practice of Total Quality in Higher Education Survey of Colleges and Universities

- How The Survey Was Conducted
- How Data Were Analyzed
- Characteristics Of Institutions In The Survey
- How And Why Institutions Began TQ
- TQ Training
- Has TQ Worked?
- Reflections On TQ

Matrix - Status of TQ in 22 Institutions of Higher Education

Case Histories - Examples of Total Quality in Practice

- Research Universities
  - Oregon State University
  - The Pennsylvania State University
- Technical/Community Colleges
  - Fox Valley Technical College
  - Delaware County Community College

Key Elements of Implementing Total Quality in Colleges and Universities

Appendix I Definitions

University Practice of Total Quality Working Council

PRACTICE OF TOTAL QUALITY IN COLLEGES AND UNIVERSITIES

Introduction

Colleges and universities are beginning to adopt the ideas and practices of Total Quality (TQ) that had been developed initially in the corporate sector. This paper reviews the current methods and results for the practice of TQ in academic institutions. We have especially reviewed institution-wide efforts, structures for implementation, the extent TQ methods are used, and the segments of institutions where TQ has been adopted.

As we discuss the practice of total quality in colleges and universities, it will be important to look at the way in which universities operate as well as the current economic environment in which they exist.

In the 8Os many institutions initiated strategic planning programs and connected these to the budgeting process. In many cases strategic planning methods were quite successful in making major advances through an involvement of faculty and staff at all levels. There are also some examples where strategic planning was not effective. It will be important for each institution to reflect on its experience in strategic planning as it practices TQ. Those who have been successful in strategic planning will probably find it easier to institute total quality.

The university is made up of three different types of personnel: 1) administration (president, vice presidents, deans, etc.); 2) faculty; and 3) staff. There are two major components - academic (colleges and departments), and nonacademic (finance, operations, physical plant, etc.) Decisions about curriculum and academic program requirements are typically made by the faculty through a system of faculty governance. Faculty governance occurs at

the department, college and university levels. Usually a faculty senate made up of elected faculty representing different academic units comprise the faculty governance at the university level. The administration and other units must consult the faculty senate when making organizational changes. In many institutions the faculty senate has defacto veto power over nonacademic institutional changes. In most instances there are detailed bylaws and policy statements outlining the role of each segment of the university in governance.

One of the better descriptions of the workings of institutions of higher education is given in a book entitled, "*Academic Strategy*". by George Keller, published in 1983. He is a strong advocate for a new management, observing that "the American university is like a tribe rife with internal dissent at the very time when external enemies threaten." And, "The American university has passed from its Golden Age to its Age of Survival." It was also observed that "universities are run by intuition, executive preferences, faculty wish lists and campus gossip." Fortunately, we have made some advances from this position through strategic planning.

"Change in universities are said to come about by incrementalism which is partisan-political and occurs through hundreds of tiny steps, no one of which is heavy footed enough to rock the boat. These steps appear as remedies, as small reasonable responses to great pressures. They need to consider self-interest and peoples territories."

Another complexity is "Department chairmen have a special difficulty with management because they often believe they are spokesmen for their colleagues in the department to the deans and presidents upstairs rather than managers of their departments' future innovativeness and quality." And finally, Keller made the observation in 1983 that "academic quality was going to be a huge concern over the next decade or two." The recent interest among many post-secondary institutions in the practice of TQ attests to prophetic wisdom reflected in Keller's statements.

Colleges and universities, like much of the rest of our society, are experiencing severe economic downturn and increased public scrutiny. Conventional wisdom tells us that, unlike in the past when we had brief interruptions to steady growth, this time we will not soon see a reversal in this decline. It is clear that the old ways of operating in universities will need to change in order to accommodate this decline in growth and demand for greater accountability.

There are some significant differences in institutions of higher education which are important in the practice of total quality. The Carnegie Foundation for the Advancement of Teaching classifies all colleges and universities into six major categories. (See Appendix I)

- Research Universities
- Doctorate-Granting Universities
- Comprehensive Universities and Colleges
- Liberal Arts Colleges
- Two-year Community, Junior and Technical Colleges
- Professional Schools and other Specialized Institutions.

For example, engineering would be found predominantly in the first two categories. Other differences exist between technological institutions (MIT, Georgia Tech, VPI), and other research universities. While the principles of total quality are the same for all institutions, these differences among institutions must be recognized in initiating the practice of total quality.

Academic Emergence into TQ[1]

Every American college or university is for quality. Every accreditation self-study documents quality. Every set of admission requirements promotes it. Every faculty member grades for it. Every promotion and tenure committee screens by it. Everyone is for quality.

Yet the last decade has brought unprecedented public demand for higher quality in colleges and universities. National reports led quickly to regional accrediting bodies requiring outcomes assessment, which itself has become a major, costly industry within our enterprise. National higher education associations are watching closely the new initiatives for testing from the U.S. Department of Education and the Presidential goals for education in the year 2000. External agencies and the public have lost confidence — we may be "for" quality, but in many eyes we do not "do" quality.

The gap is due in part to postsecondary institutions losing touch with the essential mission of the enterprise: to serve other peoples' needs. Postsecondary institutions have no legitimate claim on resources unless they serve the learning needs of society through teaching, research, and service. The beneficiaries —

[1] The following is extracted from a book, *Quality: Transforming Postsecondary Education*, by Ellen Earle Chaffee and Lawrence A. Sherr, ASHE-ERIC Higher Education Report Series, Washington, DC: George Washington University Press, 1992.

students, families, taxpayers, donors — pay for services, and they expect quite reasonably that those services will meet their needs for productive employment, satisfying lives, and a better world.

Moreover, the public believes that we cost too much. Faculty attention seems to continue to shift away from teaching, toward research. Tuition and state costs rose too far and too fast in the 1980s. Neither family incomes nor tax receipts could continue the pace. Among the recent headlines:

- Undergraduates at Large Universities Found to Be Increasingly Dissatisfied.
- A new barbarism — dogmatic, intolerant and repressive — has descended on America's institutions of higher learning. We who pay the bills ignore the outrages and subsidize those who would do us in.
- Anyone paying attention knows that the last few years, and particularly the past six months or so, have not been kind to higher education.
- Poorer Preparation for College Found in 25-Year Study of Freshmen.
- Clouded Economy Prompts Colleges to Weigh Changes.
- In an Era of Tight Budgets and Public Criticism, Colleges Must Rethink Their Goals and Priorities.
- Throughout the 80's, Colleges Hired More Non-Teaching Staff Than Other Employees.
- Public Colleges Expect Financial Hardship in 1991, as Budget Crises Imperil State Appropriations.
- Colleges Facing Severe Financial Problems.

To deal with these external challenges, a rapidly increasing number of colleges and universities are turning to Total Quality (TQ).

We have borrowed from business before, never with enthusiasm and always as a last-ditch measure to silence our critics or deal with hostile forces. TQ is different from past borrowings. The demand for financial accountability in the 196Os ushered in standard accounting measures and practices, with leadership from the National Center for Higher Education Management Systems. Pressures to maintain enrollments in the 197Os brought the concepts of competition and marketing — previously considered uncouth at best — to the ivory tower. By the early 198Os, the continuing struggle to maintain both enrollments and finances led us to strategic planning, our first sustained initiatives to think seriously about our environment, the services we render, and the need to anticipate the future.

In every case, we have modified the business tool to fit our needs. Many times, only a few campuses have explicitly adopted the tool, while others have incorporated selected pieces of it into their operations. Accounting practices, marketing, and strategic planning have fulfilled few of the gloomy predictions of their early opponents. They directly involve relatively few of our personnel, yet virtually everyone in postsecondary education recognizes these changes and can see their impact on the enterprise.

Total Quality is both like and unlike these earlier tools. Like them, it comes from business, it requires modification to suit a collegiate organization, and if applied as intended, it cannot harm our enterprise. Unlike them, it requires explicit commitment, it requires organizational transformation by adoption in its entirety, it must involve all personnel, and it will change the organizational culture. TQ is not a management tool. It is a comprehensive way of living in organizations.

On the one hand, then, TQ is the latest version of a familiar scenario that has generally brought positive results — higher education adopts business practice to a limited extent and finds some value in doing that. On the other hand, its nature and scope foretell fundamental, pervasive changes on an unprecedented scale. Some of the potential gains from taking the risk that such change entails are:

- continuously improving quality of services and products
- more satisfied students, faculty, staff, and external supporters
- greater productivity — more payoff per hour of effort
- more and better services for the same or less money
- new ways to cope with economic difficulties
- slower tuition and state funding increases.

TQ began in manufacturing firms and has only in the last decade taken hold in service firms. The shift from manufacturing to service required redefining some elements of TQ and emphasizing some parts of it over others. The experience of service firms in using TQ confirms that it is valuable for them. Compared to manufacturers, service environments are more like education organizations, and their stories are more instructive for us. Nevertheless, additional translation and modification of TQ are required to make it workable for us. Why do we believe TQ can work for higher education?

First, TQ is a comprehensive philosophy, with principles and tools. Unlike many administrative innovations, TQ is not a recipe of ingredients and steps that

must be followed slavishly in order to produce the intended result. Rather, TQ is more like a well-equipped, well-stocked kitchen. TQ has the ingredients and the mechanisms of good management, from which organizations select those that suit their needs and purposes. A community college in Maine is free to make seafood dinners, while a university in Kansas makes beef.

The second reason for believing TQ will work in higher education is its face validity — it just looks right. People, including higher education administrators, who learn about TQ often say, "Why, that's nothing but good management!" And they are at least partially correct. TQ uses many known principles and tools of good management. Perhaps its major contribution to practice is that it makes good management clear and understandable. It contains all the essential elements in one consistent package. It rejects some ingredients that have proven ineffective but remain common in practice, and it adds some ingredients that organizations have typically overlooked.

The third indication that TQ will work in higher education is that it is already working in a number of similar enterprises and a few colleges and universities. Starting in 1992, U.S. hospitals, similar to universities in many ways, must use "Continuous Quality Improvement" in order to be accredited. Management consulting firms are beginning to focus on quality improvement. The American Association of School Administrators is promoting TQ for schools and two postsecondary accrediting bodies support it. Universities and colleges that are in various stages of using TQ include Fox Valley Technical College, Delaware County Community College, Hutchinson Technical College, Oregon State University, University of Michigan, St. John Fisher College, University of Wisconsin, Pennsylvania State University, University of Pennsylvania, Colorado State University, University of Wyoming, and all eleven campuses in the North Dakota University System. The first campuses in the nation to use TQ began in about 1985, and its rapid spread began in 1989-90. We estimate that some 200 or more campuses have made a commitment to quality or are seriously considering doing so.

The Practice of Total Quality in Higher Education Survey of Colleges and Universities

As part of its study of how Total Quality (TQ) is practiced today in higher education, the Working Council on University Practice of Total Quality conducted a survey of 22 colleges and universities in August 1992. The purpose

of the survey was to learn how and why these institutions began to practice TQ, how TQ is being used now, and what results TQ has produced. The survey replicates a similar study done with 25 institutions in 1990. An update of information was thought to be valuable to colleges and universities now considering how — or even whether — to begin the practice of TQ.

How the Survey was Conducted

In August 1992, members of the Working Council on University Practice of TQ interviewed 22 colleges and universities known to be practicing TQ in a one-hour telephone interview. Respondents, who were generally Quality Coordinators at their institutions, received a letter explaining the purpose of the survey and alerting them to the telephone interview. An appointment was made so that they had time to reflect on the topic before the interview. A 54-item questionnaire gathered information on the history of TQ at the school, current TQ practice, organizational structure for maintaining TQ, and respondents' impressions of how well TQ was working.

Schools chosen for the survey had come to the attention of members of the Working Council, many of whom are active in lecturing and training in TQ. Many of the schools, which include research universities as well as community colleges, had participated in the 1990 survey. No attempt was made to include all schools who are active in TQ or even all schools who should be considered leaders. Two schools in the original interviewing pool were eliminated when it became clear they were not yet actually practicing TQ. Thus all schools in the survey were practicing TQ, which qualified them for the survey.

How Data Were Analyzed

Since many of the questions were open-ended, a content analysis was conducted on responses so that key themes emerged. Closed-ended responses were simply tabulated. A matrix (attached) displaying key data for each school was prepared and approved by the respondent before publication.

Characteristics of Institutions in the Survey

Schools surveyed ranged from large research universities to small colleges. Eight of the 22 schools had budgets of more than 75 million dollars and more than 1000 full-time faculty. On the other hand, 6 of 22 had budgets of less than 25 million per year and under 150 full-time faculty. Most of the schools were relatively new at the practice of TQ with 17 of the 22 having been practicing TQ for four years or less. Only 5 of 22 had at least five years experience with TQ.

All schools offered TQ courses to students and 17 of 22 claimed to have integrated TQ into their academic programs. Nearly all respondents (21 of 22) believed that TQ practice existed to some degree in their administrative areas such as physical plant, human resources, etc. Most (18 of 22) felt TQ could also be seen in student services such as counseling, libraries, financial aid office, etc.

How and Why Institutions Began TQ

Committing to TQ. All respondents were able to identify the year their institution officially committed to TQ and most knew how long TQ was studied before making the commitment. About half of the schools (12 of 22) studied TQ less than six months before deciding to begin the practice of TQ. In fact, 3 of the 22 reported no pre-study or formal consideration period. On the other hand, 6 of the 22 took a year or more to study TQ before deciding to implement. No schools displayed a pattern of 6 months to a year of study before committing to TQ. Schools showed one of two patterns — quick commitment with a short period of deliberation or commitment after a long period of study.

At 13 of 22 schools, the President had been involved in committing the school to TQ. In fact, at 9 schools it was the President alone who made the commitment. However, equally as often (in 9 of 22) a group of administrators made the decision.

Triggers and Goals for TQ. The most frequently cited trigger for beginning TQ was a contact with industry (8 of 22 schools). Others (5 of 22) mentioned visits to or by other schools or to industry. These schools were evidently propelled into TQ by internal forces, i.e., their own desire to get into TQ after observation and exposure to the concept. However, it was equally as common for a school to cite some external force as the trigger, such as declining enrollment, negative fund balances, downsizing, fear/danger, or needing to change the culture. As one respondent put it, "Things needed fixing."

Just over half of the schools (13 of 22) hoped to achieve an improvement in their services or become more customer-oriented with TQ. Others (9 of 22) simply cited improvement or improved quality. The third leading goal cited was cost savings/better efficiency of operation (8 of 22), followed by improved employee morale, input or participation (5 of 22).

TQ Champions & Resistance to TQ. The champion or early adopter of TQ most often mentioned was the President (12 of 22), followed by deans and vice presidents (9 mentions each), and the provost (6 of 22). Faculty members were

mentioned as champions at four schools. However, when asked to identify positions or departments offering resistance to TQ, respondents most often mentioned faculty (6 of 22), followed by the "frozen middle" management (5). Seven schools could think of no particular pattern of resistance or, in the case of a few schools, any resistance. The idea that drew the most resistance was the concept of the "customer" or the "customer-focus" in TQ (6 of 22). Other TQ concepts that generated resistance were empowerment of employees (5 of 22), the team concept (4 of 22), the possibility that TQ may be a fad (3 of 22) and the business-related language of TQ (3 of 22).

Where TQ Started Initially. In just over half of the schools (12), individuals or departments had begun the practice of TQ before the institution as a whole. These were generally industrial education departments, academic support areas, or a business professor. Other departments within the administrative services sector of the school were also mentioned. In fact, 12 of the 22 schools said TQ had started in their administrative services, largely because these processes are more amenable to TQ and it was easier to start there. Some (8 of 22) launched TQ in both their academic and administrative sides at once because they wanted to involve everyone or as at one school, "We never considered making a distinction." In only two cases was TQ begun first on the academic side of the school.

TQ Training

All schools had offered, or in the case of one school, were planning to offer training to groups of employees. The people trained first were generally senior managers or administrators, followed by middle managers. The most frequent type of training offered was an overview of TQ theory and principles (8 of 22) and facilitation training (7 of 22). Other training topics included the seven tools (5), awareness training (4), and a variety of other content areas such as Hoshin planning, customer service, process management or continuous improvement strategies. Most schools (14 of 22) relied on a combination of internal and external training providers.

To date, the 22 schools have made most progress training the management with 12 reporting that all their managers have received TQ training. Nine schools reported training 100% of their support staff, while only five had trained all faculty. In fact, at half the schools, less than one-quarter of the faculty had received training. The most effective training has been team leader/facilitator

training (5 of 22), followed by "tools" training (4), and initial awareness training (4).

Organizing the Institution for TQ Teams. All but one school had a steering committee to oversee TQ practice, the size of which ranged from 6 to more than 20 people. All but four had TQ coordinators or offices, frequently with the coordinator reporting directly to the president. Faculty and staff participation in TQ was voluntary in all but 5 schools.

Continuous improvement teams had been established in all but two schools. Typically, schools had between 1 and 20 teams operating and they expected more teams to form next year. Eleven of 22 schools formally and regularly documented team efforts by describing the process and tools used, while 9 of 22 also documented the results achieved by teams. Tools commonly used in TQ were the seven basic tools (21 of 22), cross-functional teams (19 of 22), seven management and planning tools (17 of 22), and benchmarking (16 of 22). The seven tools (both sets) were by far the tools "used most often."

Models & Gurus. When asked if teams had relied on a specific model, most respondents (16 of 22) said they used a model. The models mentioned included (in order of frequency) the seven-step problem approach (4), seven quality tools (2), Plan-Do-Check-Act model (2), OSU model (2), Deming (1), Team Handbook strategies (1), IBM's model (1), QI story (1) and Juran (1). When asked if the school had relied heavily on any particular "quality guru," model, or consultant in implementing TQ, 15 of 22 respondents believed that their schools had done so. The most common guru mentioned was Deming (9 mentions), with Oregon State, INTEL Corporation, IBM, GOAL/QPC, Fox Valley Technical College and Juran mentioned once or twice.

Funding TQ. Nearly all schools in the survey (18 of 22) had committed funds for TQ, although most were unable to identify how much had been spent to date. Estimates of annual expenditures on TQ ranged from $10,000 to $250,000. This money was used to fund training, the quality coordinator position, and other TQ office expenses. Although the institutions had spent money on TQ, only 7 had a TQ budget, special allocations or set-aside dollars from the central budget. Much of the TQ training was funded through staff development budgets, local department budgets or some combination. Only two schools had used grant money to start TQ.

Has TQ Worked?

A section of the questionnaire asked respondents for their assessment of how TQ had affected certain operations, where current support for TQ existed within the institution, and whether TQ seemed to be working. Answers, of course, reflect only the perception of the respondent interviewed.

Effects on Operations. Clearly, the operations most affected by TQ were strategic planning and operational planning, with half (12 and 11, respectively) of the respondents saying TQ had affected these processes to a very great extent. The remaining schools felt that TQ had affected these planning processes to some extent. Job descriptions, hiring practices, budgeting processes, and student assessment had been affected somewhat, with anywhere from 10 to 14 schools reporting effects to "some" or "a great extent." Employee performance appraisals were least likely to be affected, with 5 schools reporting no influence whatsoever on that process.

Level of Support. Support for TQ comes most often from the upper management, with 14 of 22 respondents classifying their President's/CEO's support as "strong," 13 noting strong support from vice presidents, and 8 noting strong support from the provost. Support staff also appear enthusiastic about TQ, with 9 of the 22 schools reporting strong support. Mid-level management, Deans, department heads and faculty were described as strong supporters of TQ at fewer than 4 of the 22 schools.

Evaluating TQ. All respondents who had been practicing TQ long enough to judge thought TQ was working in their institution. When asked why, several cited intangibles such as a "widespread sense of excitement around campus," "tremendous interest and support," "the change of culture," or that "quality has helped our sense of community... gives us a sense of purpose together." However, others pointed to specific, measurable gains in enrollment, "measurable, documented successes" or having "saved some monies." Their responses reflected a combination of quantifiable results and more subtle changes. In spite of their positive comments, few schools had a formal evaluation system in place, although several schools had efforts underway. A Baldrige assessment, student or staff surveys, customer satisfaction surveys, organizational climate surveys, audits and a "yearly, complete radar diagram" were examples of evaluation efforts.

Reflections on TQ

Finally, respondents were asked to reflect on their school's experience with TQ with the goal of generating useful advice for schools now beginning TQ. Thinking back to their greatest barrier in starting the practice of TQ, several respondents mentioned "the fad issue." Others mentioned the difficulty of moving from awareness to real integration in everyday work life, i.e., getting across the concept that continuous process improvement is part of one's job — it isn't a case of "go to training, then go back to business as usual." Several respondents discussed the difficulty of breaking through various fears — of the unknown, of losing a job, of change or of the "revolutionary nature of TQ."

What Respondents Would Do Differently. If they were once again launching TQ on their campus, what would respondents do differently? Most frequently mentioned was that they would have involved faculty differently. As one respondent said, "We should have had more contacts between faculty supportive of TQ and other faculty rather than relying on an outside consultant to provide the same training to faculty." Another school noted the need to bring in for faculty "thoughtful people who know about teaching, assessment, and instructional design." A third school would have put faculty on the steering committee. Besides faculty, involvement of middle managers and support staff were each mentioned once as an action that should have been carried out. Another theme was that respondents would have started with small successes and not tried to "bring everyone on board at once." As one respondent put it: "Focus narrowly and seek some successes rather than training too many people." Several schools would have offered more tools training or practical implementation training to those attempting to practice TQ.

What Respondents Would Do Exactly the Same Way. In spite of these mistakes, respondents said they would repeat some actions. These successful actions were diverse and did not fall into any neat, thematic categories. For instance, one school would again develop internal training, while another would again seek input from outside and retain "a competent consultant that could connect with our people." Some schools liked their approach of involving the whole campus and involving everybody as much as possible. However, another would again use the "soft sell approach... let them get excited and come to you." Several liked the way they started TQ (with benchmarking, strategic planning, or facilitating quality teams, executive education, focus on mission/vision) but the

ways mentioned were not the same at the schools. A wide variety of approaches had apparently worked at these institutions with no one "right thing" emerging.

Advice to Educators. Overwhelmingly, respondents' advice to educators now considering TQ was to take it slow. "Study it longer," "spend at least a year reading — don't do anything until you have a broad picture," "visit other campuses before making decisions" and "don't just identify a model and go with it" were comments illustrating this theme. Once started, TQ practitioners should have the patience for a long-term change effort and living with the natural pace of change. Most respondents in this survey would agree with the person who said, "Take longer and do it in a way that is best for people."

Status of TQ in 22 Institutions of Higher Education

Institution	Institution's operating budget 1	Number of years practicing TQ 2	Used in admin. services 3	Used in student services 4	Offers TQ courses 5	Used internal (I) or external (E) trainers 6	Number of continuous improvement teams 7	Number on TQ Steering Committee 8	Has TQ Coordinator/Office 9	Trained 50% or more of mgmt./admin. 10	Trained 50% or more of support staff 11	Trained 50% or more of faculty 12	Has direct funds committed for TQ 13	Participation in TQ mandatory 14
Arizona State University	240M	1	★	★	★	I	12	7	★				★	
Arizona, University of	200M	1	★	★	★	E	3	6	★				★	
Belmont University	23M	3.5	★	★	★	I	36	6	★	★	★	★	★	
Colorado State Univ (Bus/Fin Services)	350M	4	★	★	★	I&E	10	14	★	★	★	N/A	★	★
Delaware County Community College	27M	7	★	★	★	I&E	12	12	★	★			★	
Drake Business Schools (New York)	7M	4	★	★	★	I&E	2	9		★	★	★		★
El Camino Community College	55M	3	★	★	★	I&E	27	15	★	★	★		★	
Fox Valley Tech	48M	7	★	★	★	I&E	24	10	★	★	★	★	★	★
Georgia Tech	350M	2	★	★	★	I&E	12-14	18	★				★	
Hawkeye Institute of Technology	14M	4	★	★	★	I&E	6	15	★	★	★	★	★	
Lakeshore Tech	20M	7	★	★	★	I&E	4	7	★	★	★		★	
Maryland, University of	500M	1	★	★	★	I&E	10	15	★				★	

Status of TQ in 22 Institutions of Higher Education - Continued

Institution	Institution's operating budget 1	Number of years practicing TQ 2	Used in admin. services 3	Used in student services 4	Offers TQ courses 5	Used internal (I) or external (E) trainers 6	Number of continuous improvement teams 7	Number on TQ Steering Committee 8	Has TQ Coordinator/Office 9	Trained 50% or more of mgmt./admin. 10	Trained 50% or more of support staff 11	Trained 50% or more of faculty 12	Has direct funds committed for TQ 13	Participation in TQ mandatory 14
Michigan, University of	1.8B	1	★	★	★	I&E	8-10	21	★				★	
Milwaukee School of Engineering	30M	5	★	★	★	E	12	None		★	★	★		
Minnesota, Duluth, University of	60M	1.5		★	★	E	8-10	20	★				★	
North Dakota State College of Science	13M	1	★		★	I&E	3	22	★	★	★	★	★	★
Northwest Missouri State Univ	43M	5+	★	★	★	I&E	Unknown	None	★	★	★		★	
Penn State University	1.4B	1	★	★	★	I&E	20	16	★				★	
Pennsylvania, University of	1.4B	3	★	★	★	I&E	20	7	★	★				
Portland State University	72M	8 mo.	★		★	E	7	15	★				★	★
Oregon State University	286M	2	★	★	★	I	78	6	★	★			★	
Tennessee, University of (Coll of Bus)	16M	11	★	★	★	I	None	None		★			★	
Wisconsin-Madison, University of	1.2B	4	★	★	★	I&E	40	None	★		★		★	

CASE HISTORIES

Case History: Pilot Quality Improvement Projects at Oregon State[2]

Background

Oregon State University began using TQ in administrative areas in 1989. During the first year, teams tried 10 pilot projects to improve their processes and to evaluate the potential value of TQ for the university. The university required that solutions add no new costs or personnel.

The improvement projects were in physical plant, printing and mailing, budget information, computing services, business affairs, public safety, radiation center, and staff benefits services. Here are some of the improvements:

- Reduced average duration of remodeling jobs by 23%.
- Implemented improvements expected to reduce pre-printing process time by 50%.
- Improved the Budget-Status-at-a-Glance form to meet customer needs and cut preparation time by 50%.
- Decreased the number of journal vouchers returned to departments for error correction by 94%.
- Decreased time to process grant/contract documents by 10%.
- Increased the number of daily building security checks by 17%.
- Increased the number of phone calls getting initial human response by 40%.

Teams collected a great deal of data before, during, and after implementing their solutions, such as average duration of remodeling jobs, month by month; total number of lost days in the pre-printing process, by cause; journal voucher error rate, by cause; and number of days required to set up a grant or contract account, by weekly average.

Here are some comments from team members:

- "People see that there are ways to change things and that they do have a voice in the process. We have changed attitudes."
- "One benefit I am seeing is management's cooperation in listening to employees. There is more communication. And there's a growth in

---

[2] The following is extracted from a book, *Quality: Transforming Postsecondary Education*, by Ellen Earle Chaffee and Lawrence A. Sherr, ASHE-ERIC Higher Education Report Series, Washington, DC: George Washington University Press, 1992.

teamwork. People are starting to think: `When I do something, who else down the line will be affected?' That's a positive thing."

- "TQ will be great if they let the people below management level come up with the problems and use the process where it can be most productive."
- "TQ encourages people to think and work collectively in the interest of goals beyond individual performance. It enhances the organization's efficiency."
- "TQ works best if you take problems in little chunks. As soon as we narrowed the issue to the journal voucher process, we started to move."
- "We thought we knew what our problems were. TQ helped us find out what they really were. TQ has given us a process to use in the future.

The university's evaluation of all the projects and teams found that nearly two- thirds of the team members and nearly three-fourths of the team leaders had an overall positive opinion of TQ. Despite strong signals of upper management's interest in TQ such as commissioning the pilot teams, more than half the team participants believed they had not seen visible support from the top. A major concern of participants was the difficulty of finding time for their project work while also maintaining their normal workload. The bottom line? Seventy-one percent agreed that teams should be formed at all levels of Finance and Administration to improve processes (Coate, 1990a).

Case History: The Pennsylvania State University

Background

Penn State is a state-related public research university, with a strong land-grant tradition. Since the 1930's Penn State has been Pennsylvania's largest source of undergraduate degrees. In 1990, it offered studies in about 160 baccalaureate and 140 graduate fields, and granted nearly 12,000 degrees. Penn State has eleven academic units that confer degrees. Seventeen Commonwealth Campuses offer the first two years of study in most of the University's baccalaureate curriculum. Penn State ranks among America's ten largest universities.

Relatively speaking, Penn State, as an institution, is a newcomer to the practice of total quality. In 1990 the College of Engineering under the leadership of former Dean John Brighton, initiated a dialogue about quality practices with corporate members of advisory bodies to the college who were urging the adoption of TQ methods and practices. The College became a member of the

Total Quality Council of Central Pennsylvania. TQ was introduced into the Industrial Engineering curriculum at both the undergraduate and graduate level in 1991. Other departments in the Eberly College of Science and the Smeal College of Business were learning how knowledge of total quality management might better prepare students for employment opportunities after graduation. Thus, there existed pockets of TQ activity throughout the University.

A university-wide initiative began in the fall of 1991, when President Joab Thomas and Executive Vice President and Provost John Brighton charged a sixteen member council to study total quality concepts, their application in colleges and universities, and to develop strategies for implementing the practice of quality at Penn State. The Council's membership is senior administrators representing both academic and non-academic departments. It is chaired by the Dean of the Eberly College of Science.

Implementation

The Council has worked to establish a vision and direction for the practice of quality. This vision statement guides Penn State's Continuous Quality Improvement initiatives.

To achieve this vision of distinction, the Council has identified five principles that will guide the practice of quality: leadership and long term commitment; common approach and structure; teamwork and the University as a system; CQI education and human resource development, and assistance and networking. These principles are described in the document "A Statement of Purpose and Principles" written by members of the University Council on Continuous Quality Improvement. The Council meets twice a month to plan for and monitor the practice of quality.

In January and April 1992, the Council invited Nancy Howard, the Quality Manager at Oregon State University, to conduct training seminars for persons interested in learning how to apply the Oregon State model at PSU. Senior administrators were asked to send prospective team leaders and facilitators to the 2-1/2 day workshops. The workshops generated much interest and discussion within the University community. A workshop for the Council of Academic Deans, the Campus Executive Officers, and the President's Administrative Policy Council was held on June 3, 1992. Representatives from Motorola and Bell Atlantic discussed the practice of quality within their organizations. Academic administrators from the University of Pennsylvania,

the University of Michigan, and the North Dakota University System shared their quality stories and Larry Sherr, professor of Business Administration, at the University of Kansas, conducted a 3 hour introductory session on TQM. Dr. Sherr's presentation was well received, and he was invited back to repeat his presentation to academic department heads September 24 and 25, 1992.

The University Council in addition to sponsoring these training sessions for executives, administrators, and prospective team leaders and facilitators, recommended the University institute a CQI Center and appoint a full-time director who would report to the Provost. In April 1992, a director was appointed. The CQI Center will develop an education/training model assisted by a CQI Curriculum Education Team, establish and maintain information about improvement processes, assist sponsors and teams in implementing improvement processes, work closely with the Council to publicize and promote quality initiatives, and review policies and procedures within a CQI context, for recommended study.

Progress to Date

The UCCQI has identified critical processes and encouraged other groups such as; the Council of Academic Deans, and the Campus Executive Officers to do the same. Pilot teams have been established throughout the University in both administrative and academic areas. Several of these teams are cross-functional and have joint sponsors. Teams are using a collaborative problem solving model for process improvement and are reporting progress and improvement to the team sponsors and the CQI Center. The College of Education has developed the Center for Total Quality Schools that is a focal point for training and research on total quality leadership in schools. This is but one example of how colleges are seeking ways to strengthen relationships with suppliers and customers.

Training is being offered through the Human Resource Development Center, in the Office of Human Resources, to any interested faculty or staff. The management development faculty, from the Division of Continuing Education, and HRD trainers, serve as instructors in the introductory sessions. A team has been appointed to build an educational/training model, to develop a Penn State case study to be used in training, and to determine the best method for delivery in a multi-campus system. The goal is to provide continuous on-going training to teams on a just-in-time basis using internal trainers.

The University Council on Continuous Quality Improvement has served as a model for academic and administrative units wanting to practice quality. Several divisions have formed their own mini-councils to study and implement improvement processes within their areas. These councils are identifying critical processes, forming study teams around these processes, and initiating training for team members.

Summary

In a large complex institution, change can not be mandated. Models for the practice of quality must be flexible and responsive to the needs of the particular department or administrative unit. The role of the council is to appreciate the diversity within the University system, recognize the inter-relationships among people, processes, and units, breakdown barriers, and remove roadblocks to change by strengthening intraorganizational communications.

The Council has stated a vision of quality, developed principles for the practice of CQI, and has provided a common focus through its existence and its establishment of a CQI Center.

The University has positioned itself to "do" quality. Our efforts have been deliberate and systematic. Our goal is that as individuals and as an institution, the practice of quality will become a habit; something we are, not something we do.

Case History: Fox Valley Technical College

Background

In 1985, the President of Fox Valley Technical College, Dr. Stanley Spanbauer, was meeting with his CEO Council, representatives of small and large businesses within the college district. The formation of this council was part of an ambitious economic development initiative begun by the college. At the conclusion of this particular meeting, a council member, CEO of a local paper company, approached Dr. Spanbauer with a request for customized training. FVTC had been increasing the amount of training being done in companies and welcomed such requests. This particular request was for quality or "zero defects" training.

Dr. Spanbauer decided to look into "quality" to investigate the scope of local business involvement in TQ to determine if we should get involved in training. He did some reading and local research and was intrigued, seeing the possibilities for implementation at FVTC as well as the training opportunities.

He has said since that he really had no idea what he was unleashing. That it was a significant initiative and good for the college, he had no doubt, but he had no conception of the eventual impact Quality First, as we then termed it, would have on the college.

Fox Valley Technical College is a two-year, post-secondary institution offering associate and vocational degrees in over 60 programs. Full and part-time employees number over 608; 250 of those are full-time instructors and the college employs 1,300 to 1,500 adjunct faculty. FVTC is one of 16 districts that make up the Wisconsin Vocational, Technical, and Adult Education system. The FVTC mission is to promote education as lifelong learning to prepare students for entry-level and continued employment; in short — education for employment.

When FVTC began to practice quality improvement, the college was healthy. Placement rates and enrollments were good. Finances were a problem but not yet a serious one. In no way was FVTC a school in crisis. Dr. Spanbauer just hoped we could use Total Quality to make FVTC even better.

First Phase of Implementation

It is important to note that when FVTC began exploring TQ, we found no educational models. Our examples came from local business and industry and those efforts were really in their infancy. We all had a lot to learn. FVTC began with our outside consultants' quality model which was used by the paper company that introduced us to TQ. We had a local mentor.

Our first phase of implementation could be characterized by the following beliefs:

- quality is everyone's responsibility
- a comprehensive quality model is the best (not just an element of TQ such as SPC)
- a focus on improving organizational climate will lead people to want to do a better job
- we have customers

Activities during the first phase included:

- establishment of a steering council and quality coordinator
- mandatory quality awareness training for all employees
- college-wide committees on recognition, quality awareness, measurement, and education

The first phase was successful in creating awareness of TQ among all employees. Even adjunct faculty were paid to participate in workshops on TQ. We did manage to get the word out.

The first phase was also successful in creating awareness and acceptance of the concept of customers. The notion of internal customers probably led to some initial confusion. Employees were not sure whether to focus on their recently discovered role of internal customer or their more traditional role of product/service provider, and they tended to focus on the former.

We have discovered since, that employees of many schools and colleges balk at either the concept of customer or the term. In our early implementation, we did not anticipate such a reaction and did not really get it. The word customer is used consistently and comfortably throughout the college including, or especially, in reference to students.

The training was another aspect of early implementation that proved worthwhile. While the mandatory nature of the training was provocative to say the least, employees for the most part enjoyed the training. A wonderful, incidental benefit was that people got to know each other through the training. Some classes took class pictures. One even held a class reunion. Just allowing educators to get together for 20 hours and discuss education and quality was exciting.

Another critical area of improvement was in relationships with the two unions: the Educational Support Personnel Association and the Faculty Association. They were embraced in three major ways. Dr. Spanbauer set up a Futures Committee made up of union leadership and administration to explore FVTC's future together. He met with the Executive Committees of both unions monthly to talk openly, answer questions, and discuss concerns. When the bargaining process slowed down, the normal course of events at FVTC, the administration and board responded quickly and for the first time in history, multiple-year contracts were settled with both unions. There is no doubt that this paved the way for acceptance and practice of TQ later.

Other aspects of early implementation were not as successful. Some of the college-wide committees struggled with their missions. The creation of the committees resulted in a new structure that paralleled the existing structure furthering the idea that quality was something different than regular operations.

The focus on quality as "everyone's" responsibility ignored the greater initial responsibility of management. The introduction of a comprehensive model was

overwhelming. There were so many things to focus on at once — awareness, training, improvements, climate, and measurement.

The end of the first phase found the college at a standstill. Certainly people had an awareness of TQ. Early champions had taken off with it and the unions were listening, but on the whole the organization had not transformed to the extent TQ seemed to promise.

Transition

This was a time to regroup. The steering committee had to take a look at what we had and had not accomplished and why. The first thing we questioned was the model we were using. Our first model did not seem particularly suited to education. The works of Deming, Juran, Conrad, and Albrecht were reviewed, and the college developed its own 16-step model that seemed at the time to be inclusive of all three models with some ideas of our own thrown in.

In particular, FVTC needed to address the following:

- TQ was not reaching the department or natural work group
- TQ was taking on a negative focus
- employees were not sure of what they should be improving or how to go about it
- employees saw their regular day-to-day work as one thing and TQ as something else

The new model was just one step in addressing these concerns. In addition, the scope of training needed by FVTC employees began to be obvious. Wanting to implement continuous improvement is one thing; having the capacity to do it is another. We had been heavy on awareness and light on TQM applications on-the-job and the use of tools and techniques. Planning for a full-time training director at FVTC and a long-term training plan began.

Second Phase of Implementation

Goals of the second phase were to address these concerns: to improve customer service applications, to get tools to people, to integrate TQ with operations, and to balance college-wide improvements with work unit improvements. A complete set of quality elements was established and applied throughout the College. These elements contained indicators of excellence (conforming requirements) in curriculum and instruction, management/leadership, customer service, use of technology, human

resource/organizational climate, and marketing. These formed the basis for college-wide assessment in both instructional programs and service departments.

To that end, each work unit in the college was asked to select an area for improvement for the year. A group of 24 facilitators were trained in problem-solving and SPC. On the plus side, many departments applauded the effort to provide them with an opportunity to practice TQ in the natural work group. For some people, it was the first opportunity since awareness training to talk about TQ.

On the minus side, people without training had to rely on on-call facilitators and often did not know when to call them. This reinforced a growing suspicion that much more training would be needed. The SPC training did not take hold across its organization.

As a result, two mandatory courses were launched:

- Process Management — a 36-hour course for managers
- Educational Support Staff Training Phase II a 36-hour course for support, service, and technical staff

The Process Management courses brought much needed tools and strategies. Managers were required to complete an improvement project as part of the course resulting in nearly 50 projects, many of them producing dramatic results. The course for support and service staff was TQM Application training. The 160 service staff recommend instruction and practice in how to apply TQM in everyday work. While the main focus was on customer service, instruction was also given in team building, TQM concepts review, problem solving, telephone techniques, and time management. Participants also developed an action plan to apply TQM in their jobs.

To address integration issues, the existing Administrative Council of 24 managers and administrators was merged with the Quality Improvement Council of 14. A consensus building process was used in the merger with much employee input leading to the formation of the Total Quality Leadership Team of 10.

Membership includes three support staff, three faculty, three managers, and the president. The team models TQ in their practices and processes. In addition, the management performance appraisal system was partially revised to begin to recognize managers for accomplishments relating to customer service, process improvement, and team empowerment — are the application of quality elements. This alignment of values was critical.

To address work unit involvement, the school established a vision for self-management and a step-by-step process work unit could follow to move responsibly towards self-management.

At the end of the second phase, things looked considerably better. Plan-Do-Check-Act was becoming part of the vocabulary. The seven basic tools and seven management and planning tools were a breakthrough in themselves — so many of them easy to use, visual, and consensual.

Customer research had doubled and more of it was being done by work units and being put to immediate use.

Teams were moving past "lip-service" empowerment to meaningful levels of empowerment.

There was considerable progress.

Third Phase of Implementation

Similar to the Service Staff course, this training focuses on the direct applications of TQM to the teaching/learning process. The instructional phase is already underway. Faculty will be participating in a 36-hour required course on applying TQ in the classroom. FVTC will soon offer a guarantee to employers that all graduates of FVTC are competent in TQ. This means faculty will be incorporating TQ as course content and using TQ to improve the instructional process.

Integration will continue as we begin to see TQ as part of doing business rather than an add-on. We are already growing more experienced and flexible in applying the tools and strategies and in integrating them one with the other. Conflict resolution and PDCA planning make a nice fit, for example: During the current negotiations with our unions, mutual gains bargaining has been used and this has created a favorable reaction across the organization. Front-line staff continue to come up with new ways to improve services to customers. Managers are beginning to empower their members to handle complaints directly and positively.

Measurement is taking on new meaning as new information systems create segments which help to improve schedules and detail costs of productivity lapses. A costing model is being used.

Individual professional development plans are being agreed upon, input on the computer, and implemented through resource allocation. The professional

growth budget now exceeds two percent of the annual budget as there is a new recognition to the importance of staff education.

Along with improvements in products, processes, and services too numerous to mention here, the college has documented upward trends over the last five years in:

- enrollment
- graduate placement
- revenues from contracted training
- organizational climate

Student and employer satisfaction are very high and stable. Evidence of improved customer service abound throughout the campus. The TQM concept and language is being universally accepted among faculty and staff. Cost containment has also been achieved. From a research standpoint, it may not be possible to say that these trends, without a doubt, resulted from TQ practice, but those of us involved feel very strongly that they have.

Case History: Quality Improvement Projects at Delaware County Community College[3]

In 1991, Frank Topper and John Bandfield of the University of Pennsylvania visited with Susanna Staas of Delaware County Community College, which had been using TQ for about five years (DeCosmo, Parker, and Heverly, 1991). Topper and Bandfield noted:

- The first improvement project, intended to involve the president and all vice-presidents, proved too big to handle. They backed off and chose a more manageable project in admissions and registration. People calling admissions were often put on "hold" to the point that 16% hung up before speaking with anyone. Procedural changes reduced the problem to zero.
- Early teams had senior administrators as "mentors," charged with asking encouraging questions, helping find data, and advising. The mentors found it difficult to sit back and support, rather than control. Teams members found it hard to speak their minds freely. The brainstorming process, coupled with mentors restraining themselves from taking over, helped overcome these problems.

[3] The following is extracted from a book, *Quality: Transforming Postsecondary Education*, by Ellen Earle Chaffee and Lawrence A. Sherr, ASHE-ERIC Higher Education Report Series, Washington, DC: George Washington University Press, 1992.

- All teams took longer than expected, ranging from nine to 18 months. Collecting data through cycles (e.g., an academic term) contributed to lengthening the process.
- Managers had difficulty in "keeping their TQ hat on" when they went from team meetings back to their offices, which created serious credibility problems.
- Providing training when teams needed it to deal with their improvement projects was more effective than heavy investment in training before projects.
- Teams found that measuring time was more useful than measuring dollars.
- Other improvement projects have dealt with copy machines (time saved by secretaries alone paid for the solution) and staff parking (better match of lot space with users created adequate staff space and even freed up "extra" space for an additional student lot).
- Local companies are "knocking down the door" with requests for TQ training from DCCC.
- Constant reminders about making data-based decisions are needed because the tendency to jump ahead with an innovative idea is strong (personal communication, 1991).

Key Elements of Implementing Total Quality in Colleges and Universities

Based on the surveys done and the experience of the authors, the following elements are seen as key to the implementation of Total Quality (TQ) in a university setting:

1. ***Support from the top.*** Higher education institutions that have implemented TQ agree that it is essential at the outset to have a firm commitment from the president or chief operating officer of the university. W. Edwards Deming, who initiated the practice of quality management in Japan and later in the United States, found support from the top to be the single most important element in TQ implementation.

   The visible support of the president is a key element in the TQ effort. The president's early verbal and written communication about the philosophy of TQ, why it is being implemented, how it will help reach our vision, and the benefit it will bring over time, helps to gain support for the initiative and

overcome some fears of change.

As TQ gets underway, attendance by senior management at training and team meetings is an excellent motivator. At every level, managers must lead the TQ process. Each manager's job is to demonstrate continuously, both in words and in action, that TQ is a top priority. This means regularly using study teams, reviewing progress in staff meetings, providing training to everyone, and recognizing and rewarding those who use the process.

2. ***Training and involvement.*** Training and involvement in TQ should come after the immediate supervisors, of individuals being trained, have been trained and are supporters of TQ.
3. ***Focus on customers.*** Many participants in TQ teams have said that identifying, interviewing, and focusing on satisfying the needs of their customers was one of the most revealing and valuable components of their TQ experience. One of the first steps in Hoshin planning leads an institution to define its major customer groups, identify and prioritize their needs, and translate those needs into university priorities.

   Students, for instance, are our purpose of existence. We must provide them with what they need to succeed in their lives. Seeing students as customers leads us to listen to them and design our programs to meet and exceed their wants and needs.
4. ***The courage to "just do it" or "take it slow."*** Some advocate moving quickly and not to "study it to death," while others suggest that one should take time to study, look carefully at what others are doing and have a lot of patience. The pace should allow opportunities for mid-course corrections where necessary.
5. ***Top management breakthrough (Hoshin) planning.*** Not all TQ programs include breakthrough planning. However, it helps in vertical alignment, integration of strategic planning processes already underway, and in focusing quality improvement efforts on processes that can really make a difference. Identification of the president's critical processes is the first step toward identifying critical processes for every campus unit. A critical process then provides a focus for each quality improvement team.
6. ***The teams are everything!*** Focusing on continuous process improvement is what TQ is all about, and this can only be done by TQ teams. Team leaders and facilitators need adequate training in TQ and the tools of the team process before they begin. Managers who serve as team sponsors need to

commit to implementation of team recommendations, working closely with teams during the study process as members identify criteria that will make solutions workable.

The team process focuses the institution on "delighting" its customers, and customer satisfaction is a powerful motivator. Team experience also develops employees' team-building and problem-solving skills and can enhance morale.

7. ***You need a champion.*** You need a champion to provide leadership for the TQ process. Implementation takes a long commitment — five years or more. It consumes a lot of time — up to 20 percent of a leader's effort. It costs money. Someone has to be the champion to establish TQ and keep it going — to ensure that training is offered, teams are established, solutions are implemented, and results are gathered and communicated.
8. ***Try the service side first.*** In a university setting, the service sector is usually an easier place to begin TQ implementation than the academic side. Most institutions have found this to be true. Many of a university's service areas have counterparts in industry. Administrative units such as physical plant, business, and printing and mailing can more readily adapt techniques of quality improvement to their processes. What is learned from this experience can then be applied to the more complex issues of adapting TQ to the university's academic side.

APPENDIX I

DEFINITIONS

The 1987 Carnegie classification includes all colleges and universities in the United States listed in the 1985-86 Higher Education General Information Survey of Institutional Characteristics. It groups institutions into categories on the basis of the level of degree offered — ranging from prebaccalaureate to the doctorate — and the comprehensiveness of their missions. The categories are as follows:

Research Universities I: These institutions offer a full range of baccalaureate programs, are committed to graduate education through the doctorate degree, and give high priority to research. They receive annually at least $33.5 million in federal support[1] and award at least 50 Ph.D. degrees each year.[2]

Research Universities II: These institutions offer a full range of baccalaureate programs, are committed to graduate education through the doctorate degree, and give high priority to research. They receive annually between $12.5 million and $33.5 million in federal support for research and development[1] and award at least 50 Ph.D. degrees each year.[2]

Doctorate-Granting Universities I: In addition to offering a full range of baccalaureate programs, the mission of these institutions includes a commitment to graduate education through the doctorate degree. They award at least 40 Ph.D. degrees annually in five or more academic disciplines.[2]

Doctorate-Granting Universities II: In addition to offering a full range of baccalaureate programs, the mission of these institutions includes a commitment to graduate education through the doctorate degree. They award annually 20 or more Ph.D. degrees in at least one discipline or 10 or more Ph.D. degrees in three or more disciplines.[2]

Comprehensive Universities and Colleges I: These institutions offer baccalaureate programs and, with few exceptions, graduate education through the masters degree. More than half of their baccalaureate degrees are awarded in two or more occupational or professional disciplines such as engineering or business

---

[1] The years used in calculating average federal support were 1983, 1984, and 1985.

[2] The academic year for determining the number of degrees awarded by institutions was 1983-84.

administration.[3] A" of the institutions in this group enroll at least 2,500 students.[4]

Comprehensive Universities and Colleges II: These institutions award more than half of their baccalaureate degrees in two or more occupational — or professional disciplines, such as engineering or business administration, and many also offer graduate education through the masters degree.[3] A" of the colleges and universities in this group enroll between 1,500 and 2,500 students.[4]

Liberal Arts Colleges I: These highly selective institutions[5] are primarily undergraduate colleges that award more than half of their baccalaureate degrees in arts and science fields.[3]

Liberal Arts Colleges II: These institutions are primarily undergraduate colleges that are less selective[5] and award more than half of their degrees in liberal arts fields.[3] This category also includes a group of colleges (identified with an asterisk) that award less than half of their degrees in liberal arts fields but, with fewer than 1,500 students, are too small to be considered comprehensive.

Two-Year Community, Junior and Technical Colleges: These institutions offer certificate or degree programs through the Associate of Arts level and, with few exceptions, offer no baccalaureate degrees.

Professional Schools and Other Specialized Institutions: These institutions offer degrees ranging from the bachelor's to the doctorate. At least 50 percent of the degrees awarded by these institutions[2] are in a single specialized field. Specialized institutions include:

Theological seminaries, Bible colleges and other institutions offering degrees in religion: This category includes institutions at which the primary purpose is to offer religious instruction or train members of the clergy.

---

[3] The Liberal Arts disciplines include area studies, biological science, the fine arts, foreign languages, letters, mathematics, physical sciences, psychology, the social sciences, and interdisciplinary studies. Occupational/pre-professional disciplines include agriculture, the natural sciences, architecture and environmental design, business and management, communications, computer and information science, education, engineering, the health professions, home economics, law, library science, public affairs, and theology.

[4] The years used for calculating average student enrollment were 1982, 1983, and 1984.

[5] An index developed by Alexander W. Astin at the University of California at Los Angeles is used to determine the selectivity of liberal arts colleges.

Medical schools and medical centers: These institutions award most of their professional degrees in medicine. In some instances, their programs include other health professional schools, such as dentistry, pharmacy, or nursing.[6]

Other separate health profession schools: Institutions in this category award most of their degrees in such fields as chiropractory, pharmacy, or podiatry.

Schools of law: The schools included in this category award most of their degrees in law. The list includes only institutions that are listed as separate campuses m the Higher Education General Information Survey.

Schools of engineering and technology: The institutions in this category award at least a bachelor's degree in programs limited almost exclusively to technical fields of study.

Schools of business and management: The schools in this category award most of their bachelor's or graduate degrees in business or business-related programs.

Schools of art, music, and design: Institutions in this category award most of their bachelor's or graduate degrees in art, music, design, architecture or some combination of such fields.

Teachers colleges: Institutions in this category award most of their bachelor's or graduate degrees in education or education-related fields.

Other specialized institutions: Institutions in this category include graduate centers, maritime academies, military institutes without liberal arts programs, and institutions that do not fit any other classification category.

Corporate sponsored institutions: These institutions are accredited, degree-granting colleges and universities established by profit-making corporations.[7]

The Carnegie Foundation for the Advancement of Teaching 1987 Edition

---

[6] This category lists only institutions that appear in Higher Education General Information Survey as separate campuses. Those seeking a complete listing of accredited professional schools should consult publications of the separate professional associations such as the annual report on medical education published by the American Medical Association.

[7] Our list of corporate colleges and universities is taken from Eurich, Nell P., Corporate Classrooms: The Learning Business (Princeton, N.J., The Carnegie Foundation for the Advancement of Teaching, 1985). Since that report was published some of the institutions it included have become independent or part of other institutions.

Published by The John K. Howe Company, Inc., 400 Pike Street, 9th Floor, Cincinnati, Ohio 45202-4216 93JKH0079